



INTERNATIONAL
TRADE
ADMINISTRATION



2017 Top Markets Report **Civil Nuclear**

A Market Assessment Tool for U.S. Exporters

August 2017

Scan for Full Report



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Executive Summary

The U.S. Department of Commerce's International Trade Administration (ITA), Civil Nuclear Energy Top Markets Report, is a tool for prioritizing U.S. government (USG) export promotion efforts to help target limited resources toward the civil nuclear markets and activities most likely to result in U.S. exports. The report, now in its third year, is designed to inform decision makers, managers, and analysts of key trends, areas of opportunity, and important challenges facing U.S. civil nuclear energy exporters through 2032.

The intention of this report is to identify best prospect markets in the civil nuclear energy sector, including noting where USG activities can most effectively be leveraged to support the success of U.S. companies. It is not intended to be an ordering of priorities for the industry itself nor is it a direct reflection of industry priorities. U.S. civil nuclear companies represent a broad range of industry subsectors, and each has a different set of priorities and objectives. Furthermore, it is not the role of the USG to direct industry priorities but rather to identify where resources can be most effectively leveraged within current legal frameworks to support the already existing export promotion efforts of U.S. companies.

A number of important developments occurred in the nuclear energy sector between June 2016 and June 2017, including: U.S. reactor designer Westinghouse filing for Chapter 11 bankruptcy; Japan's Toshiba reporting significant financial losses; a restructuring of France's civil nuclear industry; the UK's decision to exit the European Union (EU); the Republic of Korea (ROK) announcing a nuclear phase out policy; Vietnam deferring its nuclear energy plans; Canada joining the Convention on Supplementary Compensation for Nuclear Damage (CSC) liability convention; and a significant increase in Advanced Reactor research, development and deployment activities.

With an eye on how economic and policy developments have impacted U.S. industry export prospects, ITA has updated its Top Markets rankings. Among other examples, Japan rose in the rankings due to its expanded decommission plans and efforts to restart a number of its shutdown reactors. Saudi Arabia rose due to its renewed interest in developing its nuclear program and expanded international collaboration. Conversely, Vietnam dropped in the rankings due to its announced plans to indefinitely defer its nuclear program, and Brazil dropped in the rankings due to corruption scandals that discouraged potential export opportunities for U.S. civil nuclear companies.

Countries continue to evaluate nuclear power as a low-carbon, reliable, high density energy source to meet their energy demands and climate change goals. Key export markets are shifting from the traditional and mature markets in North America and Western Europe to emerging markets in Eastern Europe and Southeast Asia. Challenges to global civil nuclear expansion remain, including low natural gas prices, barriers to financing, difficulty in developing spent fuel disposal pathways and public acceptance of nuclear energy. Consequently, strong USG-industry collaboration in the form of private-public partnerships will be essential to help U.S. companies remain globally competitive.

Overview and Key Findings

Introduction

The global civil nuclear energy industry remains a growing market with unique challenges and opportunities. This section explores the current state of nuclear energy in the U.S. and globally and identifies barriers to U.S. export competitiveness.

For purposes of this report, the global civil nuclear industry is divided into the following five subsectors:

1) *Advisory and Legal Support Services*

This subsector contains companies that provide advisory and consulting services that address the development of legal and regulatory regimes, licensing support, siting, environmental impact analyses, legal advice, and tender writing and development. Standards development and trade association activities are also included within this subsector.

2) *Design, Construction and Operation*

Companies in this subsector are responsible for technology design and engineering, procurement, project management, site preparation, plant construction, and plant operation and maintenance. This subsector addresses all activities in the engineering, procurement and construction (EPC) phase of a nuclear power plant project and also covers utilities that operate plants and companies that provide plant maintenance and repair.

3) *Components*

Companies in this subsector are generally manufacturers that seek commercial opportunities throughout a nuclear power plant's lifecycle, including parts required for operation and maintenance, uprates and upgrades. We delineate this subsector to reflect commercial opportunities for component manufacturers independent of Nuclear Steam Supply System (NSSS) providers.

4) *Fuels*

The fuels subsector includes all aspects of the nuclear fuel cycle, including mining and milling uranium, enrichment, conversion, fabrication of assemblies, refueling, transportation of fuel and fuel storage.

5) *Back-End Services*

Companies in this subsector provide services related to nuclear power plant decommissioning and used fuel management, including waste management and removal, remediation, used fuel management, interim storage and transportation, geologic disposal and reprocessing, and recycling of plant byproducts.

A number of important developments occurred in the nuclear energy sector between June 2016 and June 2017, including:

- Westinghouse Files for Bankruptcy: In March 2017, U.S. nuclear technology company Westinghouse (majority owned by Japan's Toshiba) filed for Chapter 11 bankruptcy protection, due to losses associated with the company's 2015 acquisition of the nuclear construction firm CB&I Stone & Webster, constructor of the four AP1000 reactors being built at the Vogtle nuclear power plant in Georgia and the V.C. Summer nuclear power plant in South Carolina. The announcement had an immediate impact on Westinghouse's two U.S. nuclear construction projects. In June 2017, Toshiba announced that it would provide \$3.68 billion to Southern Co., owner of the Vogtle Plant, to aid in the completion of the two reactors at Vogtle. As of July 2017, SCANA Corp., owner of the nuclear construction project at V.C. Summer was still completing internal analyses to decide its next steps on the project. Meanwhile, the outcome and impact of Westinghouse's restructuring of its planned international projects in India, the United Kingdom, and elsewhere remains unclear.
- Toshiba Reports Financial Losses: As of July 2017, Toshiba has reported \$8.4 billion in unaudited losses for the 2016-2017 financial year ending March 31, 2017. The losses stem primarily from cost overruns at Westinghouse's U.S. AP1000 projects and from Toshiba's 2015 revelation of its accounting scandal. In addition to seeking the divestiture of Westinghouse, Toshiba is seeking to sell its semiconductor business to meet its financial commitments and has several serious offers. U.S. company Western Digital – which operates a flash memory joint venture with Toshiba – is seeking arbitration on the sale through the International Chamber of Commerce.
- Restructuring of France's Civil Nuclear Industry: France's ongoing efforts to have state-owned Electricité de France (EdF), the world's largest nuclear utility, acquire a majority stake in the state-controlled Areva's spin-off entity ArevaNP, the newly created reactor and services side of Areva's business, is a critical initiative that will impact the global competitiveness of the French nuclear industry. After Areva posted huge losses in 2014, in July 2015, EdF agreed to take on 51 percent of Areva NP. The contract was signed in November 2016 and will be concluded by the end of 2017, at which time this portion of the business will be reconstituted as "New NP". New NP will hold all of Areva NP's existing assets related to nuclear power, with the exception of assets and liabilities related to the completion of the Olkiluoto 3 EPR reactor in Finland, which will remain with Areva SA, along with some Le Creusot Forge potential liabilities (especially those related to forging anomalies of the reactor vessel at Flamanville 3). In May 2017, the European Commission (EC) approved this sale to EdF.
- United Kingdom (UK) Exits the European Union (EU): The June 2016 UK referendum to exit the EU has resulted in uncertainty for the UK's civil nuclear plans. As part of its departure from the EU, a process that will take up to two years and must be completed by April 2019, the UK will also exit the European Atomic Energy Community (EURATOM) Treaty, which governs the peaceful use of nuclear energy in EU member states. Exiting EURATOM means that the United

Kingdom would need to establish new bilateral nuclear cooperation agreements with EURATOM as well as with key nuclear trading partners outside the EU, including the United States, Japan, Australia and others. The UK nuclear industry has issued public statements warning that a failure to put in place alternative arrangements to replace EURATOM would have a dramatic impact on the UK's planned new nuclear power plants (NPP) and cause major business disruptions across the nuclear fuel cycle.

- The Republic of Korea (ROK) Announces Nuclear Phase Out Policy: The country's new President, Moon Jae-in, who took office in May 2017, announced his intent to reduce the country's reliance on coal to mitigate air pollution and nuclear power out of nuclear safety concerns. Moon said plans for new power reactor projects would be cancelled and the operating periods of existing reactor units will not be extended beyond their 40-year design life. It is unclear to what extent the new government will follow through on its nuclear power reduction plans given the ROK's reliance on nuclear power and export ambitions for KEPCO/KHNP's APR-1400 reactor.
- Vietnam Defers Nuclear Plans: In November 2016, Vietnam announced that it would indefinitely defer the further development of planned nuclear power plants. Nuclear power is no longer included or budgeted for in Vietnam's commercial power plan, which runs through 2030. Prior to this announcement, Vietnam was considered a front runner for the first country in Southeast Asia to build a nuclear power plant.
- Canada Joins the Convention on Supplementary Compensation for Nuclear Damage (CSC): On June 6, 2017, Canada ratified the CSC, an important multilateral treaty relating to liability and compensation for damage caused by a nuclear incident, becoming the tenth country to ratify the agreement. Once the treaty is brought into effect by Canada on September 4th, 2017, this will bring the number of nuclear power reactors covered by the CSC up to 191 (more than under the Paris and Vienna Liability Conventions). The CSC entered into force in April 2015.
- Increased interest in New Near-term and Longer-term Reactor Technologies: The Small Modular Reactor (SMR) Company NuScale submitted in January 2017 their design certification application to the U.S. Nuclear Regulatory Commission with the hope of deploying a SMR by 2025. Additionally, there has been a surge of U.S. private sector investment in advanced reactors, totaling \$1.3 billion from nearly fifty companies promoting a range of technologies. The Department of Energy launched the Gateway for Accelerated Innovation in Nuclear (GAIN) initiative in 2016.

Key Findings: Top Markets and Methodology

With an eye on how economic and policy developments have impacted U.S. industry export prospects, ITA has updated its Top Markets rankings. Among other examples, Japan rose in the rankings due to its expanded decommission plans and efforts to restart a number of its shutdown reactors. Saudi Arabia

rose due to its renewed interest in developing its nuclear program and expanded international collaboration. Conversely, Vietnam dropped in the rankings due to its announced plans to indefinitely defer its nuclear program, and Brazil dropped in the rankings due to corruption scandals that discouraged potential export opportunities for U.S. civil nuclear companies.

Methodology

ITA's *2017 Civil Nuclear Energy Top Markets Report* ranks 50 countries in terms of their readiness for nuclear energy and openness to U.S. civil nuclear exports. Individual market ratings for exports related to new builds, existing reactors, and decommissioning were assessed on the basis of 19 variables encompassing qualitative and quantitative measures. A detailed description of each variable is located in Appendix 2.

The total score for a given market is computed by adding together three sub-sector scores—new builds, existing reactors, and decommissioning—that comprise the full spectrum of civil nuclear exports of goods and services. A detailed description of each sub-sector score is located in Appendix 2.

Industry Overview and Competitive Landscape

Status of Nuclear Energy in the United States

The United States operates the world's largest and most efficient reactor fleet and generates the most nuclear power worldwide, at 80.5 GWe in 2016. The 99 currently operating reactors include 34 boiling water reactors (BWRs) and 65 pressurized water reactors (PWRs). Nuclear energy accounts for 19.4 percent of U.S. electricity production and 60 percent of carbon-free electricity generation. Four reactor units are currently under construction: two reactors at Alvin Vogtle Nuclear Generating Plant (Waynesboro, GA) and two units at Virgil C. Summer Nuclear Generating Station (Jenkinsville, SC). Both are Westinghouse AP1000 reactors. Before Westinghouse's declaration of bankruptcy, these reactors were expected to be operational between 2019 and 2020, but that timeline will be extended. Unit 2 of the Tennessee Valley Authority's (TVA) Watts Bar 2 nuclear power plant in Spring City, Tennessee, a Westinghouse PWR in Spring City, TN, was completed in August 2015 and began operation in June 2016, becoming the first new reactor to come online in 20 years. Since 2013, six U.S. nuclear power reactors have shutdown prematurely, primarily due to economic reasons, and many more are at risk of closing in the next 8-10 years.

In addition to the four units under construction, combined construction and operating licenses have been issued for eight additional reactor units (Fermi-3, Levi-1 and -2, South Texas-3 and -4, Lee-1 and -2, and North Anna-3). Two others are currently under review by the U.S. Nuclear Regulatory Commission (NRC) (Turkey Point-6 and 7). Since 1977, the NRC has approved more than 7,300 megawatts (MWe) of power uprates, which is equivalent to adding seven large light water reactors to the grid. 88 reactors have received 20-year license renewals, and several others (River Bend-1, Perry-1, Clinton-1 and

Comanche Peak-1 and -2) are anticipated to submit license renewal applications over the next five years.

There are significant challenges to new construction of large-scale light water reactors in the United States, however, which will be discussed in more detail in the following section. These include high capital cost, long and uncertain construction timelines, record low natural gas prices, preferential grid access for renewable energy-based generation, and no growth in U.S. electricity demand since 2004.

Recently, there has been a surge of interest in advanced reactor technologies in the United States, some of which may offer solutions to the challenges posed by large light water reactors.

Light water small modular reactors (SMR) are an especially promising, near-term area of development in the United States that may help to address some of these challenges and bridge the gap between large light water reactors and non-light water advanced reactor technologies. Several U.S. companies are developing light water SMR technology, including NuScale Power, Westinghouse, and Holtec. Commercial deployment for light water SMRs is planned for the mid-2020s. In January 2017, NuScale became the first SMR company to submit a design certification application to the NRC. The NRC's comprehensive safety evaluation is expected to take 40 months. NuScale plans to have its first operating reactor up and running by the middle of 2026 on a site at DOE's Idaho National Laboratory (INL).

Meanwhile, the United States continues to lead the world in nuclear innovation. U.S. private sector investment in advanced reactors totals to \$1.3 billion from nearly fifty companies promoting a range of technologies, including fast-spectrum reactors, molten salt reactors, high temperature reactors, fusion technologies, hybrid energy solutions, and others. In addition to NuScale, 18 reactor design groups have expressed interest in building at INL. The first advanced non-light water reactors in the United States are planned for the 2030s, but there remain many technological and regulatory barriers to their deployment by this timeframe.

The U.S. Department of Energy (DOE) is supporting the domestic development of small modular and advanced reactors. Some examples of DOE initiatives include loan guarantee programs, a 50-50 cost share with the industry on small modular reactor development and deployment, and the Gateway for Accelerated Innovation (GAIN) initiative to support advanced reactor development and deployment. DOE has a partnership with NuScale, an SMR company, to help move design certification forward and assist with commercialization. Additionally, DOE has provided funding awards for X-Energy and Southern Company to help expedite design approval for the next generation of nuclear reactors. In June 2017, DOE announced \$67 million in nuclear energy research, facility access, crosscutting technology development, and infrastructure awards 14 in 28 states. In total, 85 projects were selected to receive funding that will help advance innovative nuclear technologies.

One piece of U.S. legislation that incentivizes nuclear power production is the 2005 Energy Policy Act (EPAct), which established the nuclear production tax credit (PTC). The PTC of 1.8 cents per kilowatt-hour of electricity produced by new nuclear power plants is available only for the first 6,000 MWe of

new nuclear generating capacity and lasts only for the first eight years of operation. The Vogtle and V.C. Summer plants under construction in South Carolina and Georgia qualify for these credits but, under current legislation, cannot claim the credits unless the new reactors start producing electricity by 2020. As of July 2017, the U.S. Congress was working to extend these credits beyond the 2020 deadline so that these projects can take advantage of these credits.

Global Industry Landscape

Globally, there are currently 449 nuclear reactors with a combined 392 gigawatt (GWe) capacity operating in 30 countries and 60 reactors under construction in 15 countries with a combined 60.6 gigawatt (GWe) of capacity. In terms of future growth, 170 reactors are planned in 25 countries over next 5-10 years, and 372 reactors are proposed in 36 countries over the next 10-25 years. The Organization for Economic Cooperation and Development/International Energy Agency's 2016 Global Energy Outlook Report projects that nuclear power will have to double by 2050 for the world to meet international climate change goals and the energy needs of an expanding global population, which is expected to grow to 10 billion by 2050. Many countries continue to express interest in developing or expanding their nuclear programs, although low oil and gas prices could make it harder for governments to favor policies that encourage the use of nuclear energy and other clean energy sources.

Nuclear markets are shifting from the United States and Western Europe to East Asia, the Middle East, South America, and Eastern and Central Europe. This has important implications for the global nuclear landscape after 2030. The U.S. Department of Commerce estimates the global civil nuclear market to be valued between \$500 and \$740 billion over the next ten years and to have the potential to generate more than \$100 billion in U.S. exports and thousands of new jobs.

Challenges and Barriers

Despite the U.S. civil nuclear industry's strengths, U.S. companies continue to lose significant market share to an ever-increasing number of foreign government-owned or led competitors, including Russia, France, China and the ROK. Unlike its foreign competitors, the USG owns no part of U.S. reactor design companies. Industry promotion in the United States is often fraught with challenges, especially as the USG seeks to provide equitable support and avoid making value distinctions among competing U.S. companies. Furthermore, unlike our foreign competitors, the USG does not provide sovereign backing for its companies, which places them at a competitive disadvantage in the areas of financing, commercial incentives and liability insurance.

Market challenges faced by all participants in the nuclear energy sector include: (1) financing nuclear power plants, which require long construction periods and high upfront capital costs that are not recouped until the nuclear power plant begins generating electricity. A fully functional EXIM Bank is critical to financing nuclear power project exports, and without a quorum on EXIM's Board of Directors, the Bank can only complete long-term transactions valued at \$10 million or less; (2) infrastructure research, development and demonstration (RD&D), which requires the training of a skilled workforce; a

nuclear manufacturing supply chain; an effective, independent and transparent regulatory infrastructure; and adequate RD&D resources, in particular for technology demonstration; (3) a need for spent fuel disposal pathways, particularly for emerging and small fleet markets; (4) a recognition of nuclear energy's role in providing carbon free electricity and (5) public acceptance of nuclear energy. Furthermore, global market growth has stagnated overall due to reduced electricity growth in emerging and mature markets.

Other challenges that U.S. industry has noted include (1) the length of time to negotiate and bring into force a bilateral civil nuclear cooperation agreement (123 Agreement), which are generally required under U.S. law for U.S. companies to export significant reactor equipment and components to a country, in the event of a nuclear procurement decision; (2) a vital but complicated export control process, including export controls under the jurisdiction of the U.S. NRC, DOE, the State Department and the Commerce Department's Bureau of Industry and Security (BIS); (3) an inadequate global nuclear liability regime, although the April 2015 entry into force of the CSC – and its expansion – will mitigate liability risks for U.S. civil nuclear companies doing business internationally; and (4) erosion of U.S. manufacturing capacity, as U.S. companies no longer manufacture reactor vessels or steam generators.

Opportunities

Despite these challenges, U.S. civil nuclear companies are leading innovators in global nuclear energy technology and have more than five decades of experience designing, constructing, up-rating,¹ managing and decommissioning NPPs. Many reactor designs developed in recent years offer passive safety features, lower water usage, scalability, and significantly reduced waste, which may be able to address some of the challenges posed by conventional light water reactors. U.S. industry still has many competitive strengths, including being an expert leader and pioneering the development of civil nuclear energy, top performing companies all along the nuclear supply chain, a nuclear industry known for supporting the development of local industry and helping to deepen long-term bilateral relationships, and a global recognition of the U.S. having an independent and strong nuclear safety regulator.

Decommissioning of NPPs is a growth area for U.S. industry and one where U.S. companies have significant experience and expertise. The bulk of worldwide retirements will be in mature markets, reflecting the age profile of their fleets, particularly the EU led by France, Germany and UK, Russia, Japan and United States. Decommissioning cost estimates range from \$750 million to \$1 billion per 1000 MW plant. In total, 110 commercial reactors, 46 experimental or prototypes, and 250 research reactors, as well as a number of fuel cycle facilities, have been permanently shut down; some of these facilities have been fully dismantled. Over the next 20 years and beyond, the International Atomic Energy Agency (IAEA) estimates that 150 GW (more than 200 nuclear plants) are expected to be retired, primed for or to begin decommissioning. In late 2016 the Japanese government estimated total costs from the Fukushima accident alone to date at approximately \$188 billion. The March 2011 Fukushima accident in Japan led several countries (most notably Germany and Switzerland) to move away from nuclear energy and pursue early decommissioning of their reactor fleet.

As noted in the previous section on the *Status of Nuclear Energy in the United States*, the development of advanced reactor technologies, including light water SMRs non-light water reactors, is another promising area where U.S. civil nuclear companies are making progress and aim to compete globally.

Market Categories

Generally, each market can be categorized according to its stage of interest and readiness for a civil nuclear energy program. These categories, in turn, help determine commercial opportunities for that market and the appropriate USG support strategy. This categorization was developed through the use of a flow chart (See Appendix 1) consisting of a series of yes/no questions. These categories are listed below in Figure 3.

Figure 3: Market Category Descriptions

Newly Emerging Market

- No operating commercial nuclear plants but clear government support for a civil nuclear energy program, and the country is taking tangible steps to develop the necessary regulatory framework, has established sites for its first plant or is building its first plants.
- Short-term export opportunities: advisory and legal support services, education and workforce development.
- Mid/long term export opportunities: site selection and environmental assessments; design, construction and operation; components; fuel.

Existing Market and Expanding Fleet

- Country has one or more operating commercial nuclear reactors and interest in expanding its fleet. Expansion has been noted via public announcements, tenders, construction to expand an existing plant or build a new plant and projected commission dates for new nuclear plants.
- Short-term opportunities: site selection and environmental assessments; design, construction and operation; components; fuels.
- Long-term opportunities: back-end services.

Mature and Maintaining Fleet

- Country has significant experience operating nuclear plants but does not have plans to expand its existing fleet. Political climate favors nuclear power.
- Short-term opportunities: plant operation and maintenance, components, fuels.
- Mid/long term opportunities: back-end services.

Mature Market and Decommissioning

- Country has significant experience operating nuclear plants and is currently decommissioning plants or has announced plans to do so. Political climate does not favor nuclear power.
- Short/mid/long-term export opportunities: plant operation and maintenance, components, fuels, back-end services, decommissioning and decontamination.

Figure 1: Top 25 Overall Ranking for U.S. Civil Nuclear Exports

1. UK	8. Poland	15. Romania	22. Sweden
2. China	9. Saudi Arabia	16. Spain	23. Argentina
3. India	10. Turkey	17. Slovakia	24. Finland
4. UAE	11. Canada	18. Ukraine	25. Germany
5. Japan	12. France	19. Switzerland	
6. Mexico	13. ROK	20. Brazil	
7. Czech Republic	14. South Africa	21. Belgium	

Figure 2: Top 10 Ranking by Sub-sector

<u><i>New Builds</i></u>	<u><i>Existing Plants</i></u>	<u><i>Decommissioning</i></u>
1. United Kingdom	1. China	1. United Kingdom
2. China	2. United Kingdom	2. Japan
3. India	3. Canada	3. Sweden
4. United Arab Emirates	4. India	4. Taiwan
5. Mexico	5. France	5. Switzerland
6. Poland	6. Japan	6. France
7. Saudi Arabia	7. Ukraine	7. Germany
8. Czech Republic	8. Spain	8. Rep. Korea
9. Turkey	9. Rep. Korea	9. Belgium
10. Canada	10. Switzerland	10. Canada

Country Case Studies

The following pages include country case studies that summarize export opportunities in selected markets. The overviews outline ITA's analysis of the U.S. export potential in each market. The markets represent a range of countries to illustrate a variety of points and not the top markets overall.

Brazil

Market Type: Newly Emerging

Brazil has a promising civil nuclear energy market. The country's two nuclear reactors supply approximately 2 percent of Brazil's energy. One reactor is currently under construction and the government has proposed building up to eight new reactors by 2050. Brazil is dependent on hydropower for its electricity, and recent droughts illustrate the need for energy diversification. The Brazilian government has expressed favorable opinions of nuclear power, but recent scandals involving industry leaders and broader political uncertainty will slow Brazil's ambitions to grow its nuclear fleet in the near future.

Overall
Rank

#20

U.S. Ambassador to Brazil: P. Michael McKinley
Senior Commercial Officer in Brasilia: Rick Ortiz

Market Overview

Approximately 2 percent of Brazil's energy is supplied by two pressurized water reactors (PWRs) at the Angra dos Reis NPP near Rio de Janeiro. Angra 1&2 have 626 MWe and 1270 MWe generating capacity, respectively. A third 1270 MWe reactor, Angra 3, is halfway completed, although construction has been temporarily halted due to delays resulting from a 2015 corruption probe. In May 2015, Brazil's Minister of Mines and Energy stated that Angra 3 would be the last state-sponsored NPP and that it will be sold in 2018 (Chinese and Russian investors have expressed interest), and that Brazil would seek private investment for future NPPs. The Government of Brazil (GOB) has accommodated an agenda supportive of nuclear power, and despite recent political changes, it has not indicated changes to this agenda. Brazil's Long-Term Energy Plan (PNE 2050) has not yet been concluded, and although new nuclear plants are expected to be included in this plan, the role that nuclear power will play in Brazil's long-term energy mix is currently unclear.

Recent droughts have demonstrated the need to reduce Brazil's dependence on hydropower, which accounts for a large proportion of the country's energy. In April 2015, the Ministry of Mines and Energy updated its 10-year energy plan, stating that Brazil would continue to invest in nuclear energy and that it was in the process of evaluating sites for the development of four to eight new units to be built in the future. Each unit must be approved by Congress before any work commences, requiring thorough planning on the ground level. Additionally, with the exclusion of Angra 3, the GOB has stated that construction on any new sites shall not begin until after 2020, making the probability of project ground breaking unknown. Pernambuco in the northeast and Minas Gerais in the southeast have been selected as potential sites. Due to bribery and corruption charges against Eletronuclear's CEO, doubts have been raised about the completion of Angra 3 and the commencement of any new projects. However, Eletronuclear expects work to resume on Angra 3 sometime in 2017, potentially bringing the reactor online in 2022.

The Brazilian Association for the Development of Nuclear Activities (ABDAN), a group of Brazilian companies associated with the nuclear sector, announced that it would finalize its long-term strategic plan in July 2017, to be implemented in 2018. One of the key proposals that the plan will address is a solution to conclude Angra 3. The implementation of ABDAN's plan could indicate future export opportunities for U.S. industry.

The results of a 2011 survey show that public opinion in Brazil regarding nuclear power is split, with 44 percent of those surveyed saying that Brazil should continue to use its existing NPPs but not build new ones, 35 percent saying that all operating NPPs should be closed, and 16 percent supporting the construction of new NPPs. Public opinion is generally in favor of balancing the energy mix to include nuclear with renewables, including wind and biomass. Local populations near uranium mines have expressed concerns about the feasibility of emergency plans and other nuclear-related contingencies in the event of an accident.

Planned and Potential Nuclear Energy Projects

Angra Nuclear Power Plant Expansion

Owner: State

Reactor Type: Pressurized Water Reactor

Capacity: 1405 MWe (1270 MWe net)

Value of Project: N/A

Construction Period: 2010-2022

Operation: Possibly 2022

Angra NPP: Angra 3 was originally envisioned in 1984 as a twin of unit 2. The project was suspended until the mid-2000s, and the first concrete was not laid until June 2010. Following the 2015 corruption probe, several contracts for Angra 3 were suspended. Construction of the plant is approximately 60 percent complete. The GOB is reviewing ways to restart construction.

New Northeast Nuclear Power Plant

Owner: State

Reactor Type: PWR (TBC)

Capacity: 6000-6600 MWe (four PWR units)

Value of Project: N/A

Construction Period: N/A

Operation: TBD

New Southeast Nuclear Power Plant

Owner: State

Reactor Type: PWR (TBC)

Capacity: 4000-6000 MWe (four PWR units)

Value of Project: N/A

Construction Period: N/A

Operation: TBD

New Southeast NPP: In 2013, Minas Gerais was chosen for the southeast site.

New Northeast and Southeast NPPs: Eletronuclear has proposed constructing additional NPPs in Brazil: two in the northeast and two more near Angra in the southeast, each with two reactors. In 2013, Pernambuco-Bahia was chosen for the northeast site. All eight reactors will need approval by the Brazilian Congress. Financing is likely to be problematic, as the Brazilian government has delayed construction of any new plants until at least 2020.

Opportunities

Services (front- and back-end): Opportunities to support proposed new construction plans. No opportunities for decommissioning since both Angra 1 and Angra 2 are expected to be granted life extensions to 2024 and 2041, respectively.

Legal and Consulting Services: Limited potential, opportunities for lifetime extension and supporting new construction plans.

Licensing Support: Opportunities to support Brazil's nuclear regulator, the National Nuclear Energy Commission (CNEN). CNEN's Directorate of Radiation Protection and Safety is responsible for licensing and supervising all nuclear facilities.

Design, Construction, and Operation: Opportunities to support new construction of up to eight reactors and for modifications to existing plants.

Components: Moderate opportunities to supply existing plants, one of which was built by Westinghouse, with engineering support, plant design modifications, equipment replacement, fuel components, waste handling systems, and related materials.

Challenges and Barriers

GOB support for nuclear energy is strong but uncertain. Brazil's interest in building new reactors has attracted a high-level of interest from U.S. reactor vendors, as well as Areva and Rosatom. Brazil's goals remain ambitious, particularly amid a history of delays related to the units at Angra. Cancellations due to the scandal surrounding Eletronuclear pose a challenge to civil nuclear exports. The investigation prompted the suspension of two contracts with Brazilian consortiums that were to work on the construction of Angra 3. Additionally, the proposed reactors cannot be built without the approval of the National Congress, which is not guaranteed.

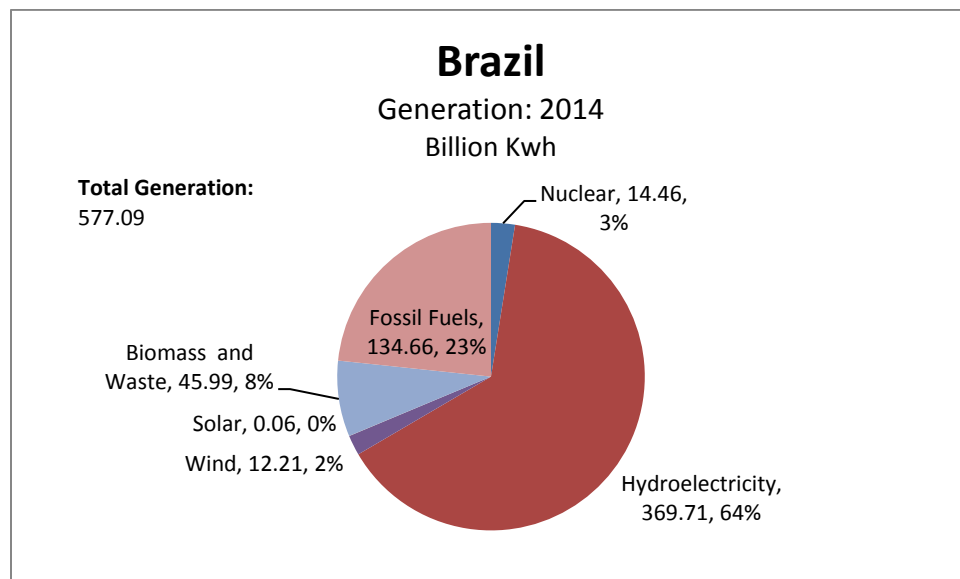
Financial obstacles exist for U.S. civil nuclear exports to Brazil. If the GOB ultimately decides to no longer sponsor any new NPPs, funding will have to come from the private sector. Doing business in Brazil requires a strong understanding of the local environment, as well as the direct and indirect costs of doing business, such as government procedures, local content requirements (Angra 3 construction thus far has about 70 percent local content), and environmental laws. Brazil's lack of infrastructure and a complex tax system may also hinder U.S. industry involvement. A final challenge is that Brazil has not identified an official procurement process for future plants, which could slow its new NPP plans.

Nuclear Infrastructure

Research reactors: Brazil has four operational nuclear research reactors. In São Paulo, there are two research reactors (including a 5 MWe pool type reactor) and a cyclotron with radioisotope production.

Fuel: Brazil has 278,000 tons of known uranium. It is mined and used domestically after conversion and enrichment abroad. Conversion is done by Areva in France. Most enrichment is conducted by Urenco in the United States or Europe. Efforts are underway to begin enriching uranium domestically. Currently, the Brazilian Navy leases the uranium enrichment technology to Brazilian Nuclear Industries and produces centrifuges for it. In 2016, Industrias Nucleares do Brasil signed a contract with Argentine company Combustibles Nuclear Argentinos SA to begin exporting enriched uranium.

Waste Management: Nuclear waste is disposed of in four temporary repositories. A long-term solution is still being considered. CNEN is responsible for management and disposal of radioactive wastes.



U.S. Government Collaboration

123 Agreement: Brazil has had a 123 Agreement with the United States since 1999. The Agreement expires in 2029.

U.S.-Brazil Strategic Energy Dialogue (SED): the SED high-level dialogue between the United States and Brazil. One of the priority areas of intergovernmental cooperation in SED is nuclear energy.

Regulatory Cooperation: The U.S. NRC and Comissão Nacional de Energia Nuclear of Brazil (CNEN) have an arrangement for the exchange of technical information and cooperation in nuclear safety and security matters. CNEN has also signed agreements with the NRC to join the Code Applications and Maintenance Program (CAMP) and the Cooperative Severe Accident Research Program (CSARP).

International Engagement

Brazil's first nuclear contract was awarded to Westinghouse. In 1975, Brazil was to develop two reactors with West Germany, but construction was interrupted due to economic issues. The construction of Angra 2 was eventually resumed thanks to funding from German banks and newly-formed Brazilian state owned companies Furnas and Eletrobras. Brazil signed agreements with Germany in the 1970s to transfer nuclear technology and jointly develop experimental technology to enrich uranium. The completion of the third reactor, Angra 3, was awarded to Areva in 2008, which is also being considered for the supply of additional reactors.

After Eletronuclear's proposal to build four more reactors, Areva, Westinghouse, and Rosatom expressed interest in the projects. In June 2015, Westinghouse signed an agreement with Nuclebras Equipamentos Pesados for collaboration on the fabrication of reactor components in Brazil. Rosatom offered a build-own-operate project, which could solve the financing issue that other bidders face.

Figure 5: Additional Agreements

Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	
Joint Convention on Safety of Spent Fuel Management	✓
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention on Third Party Liability in the Field of Nuclear Energy	
Vienna Convention on Civil Liability for Nuclear Damage	✓
Joint Protocol Relating to the Application of the Vienna Convention and Paris Convention	

Convention on Supplementary Compensation for Nuclear Damage	
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	✓
OECD/NEA	
IFNEC	
GenIV International Forum (GIF)	✓
EURATOM	

Resources

For more information on the commercial opportunities in Brazil, contact: Rick Ortiz (Senior Commercial Officer in Brasilia, rick.ortiz@trade.gov); Mark Russell, Principal Commercial Officer in Rio de Janeiro, mark.russell@trade.gov; Regina Cunha (Senior Commercial Specialist, Regina.cunha@trade.gov).

For more information on the civil nuclear industry in Brazil, contact: CNEN website (<http://www.cnem.gov.br>)

Sources

CIA Factbook, United Nations, World Nuclear Association, World Nuclear News, ANEEL, and our contacts at the U.S. Embassy in Brasilia.

Bulgaria

Market Type: Existing and Expanding

Bulgaria is considering expanding its current fleet of two reactors, but negotiation breakdowns and cancellations have delayed construction plans. Russia's presence in Bulgaria's nuclear sector represents a challenge for U.S. exporters, as does Bulgaria's financing and business environment. Public and political support for nuclear energy remains strong, however.

U.S. Ambassador to Bulgaria: Eric Rubin
U.S. Commerce Attaché to Bulgaria: Maria Galindo

Overall
Rank

#27

Market Overview

Bulgaria currently has two operational Russia-designed VVER reactors (2000 MW total) and four additional VVER reactors that are permanently shut down. All reactors are located at the Kozloduy Nuclear Power Plant (KNPP) site on the northern border with Romania on the Danube River.

Bulgaria's Energy Minister, Temenuzhka Petkova, has stated that nuclear energy is of strategic importance to Bulgaria and the Bulgarian Government (GOB). Minister Petkova noted that the GOB will strictly adhere to nuclear management programs and will work to develop new nuclear power capacity. She said that new nuclear power plants (a potential Unit 7 and 8 at KNPP) must be economically justified, without state guarantees, and must be implemented by a strategic investor.

Minister Petkova has consistently noted that any energy policy must be based on "political consensus" and that GOB's nuclear energy priority is based on ensuring the life extensions of KNPP units 5 and 6 are successfully completed. Construction of any new nuclear units must not come at the expense of the life extension programs underway for KNPP's units 5 and 6.

Kozloduy units 5 and 6 are undergoing an upgrade and modernization program. They are currently licensed through 2017 and 2019. Kozloduy Nuclear Power Plant plc signed a contract with Rosenergoatom and EDF to extend their lifetimes from 30 to 50 years. In October 2015, parties reached an agreement for Rosatom to modernize unit 5 by May 2018 with a project cost of €24.7 million. The GOB is under pressure to modernize the units to keep electricity prices low.

In March 2015, Bulgaria delayed its plan to build a new reactor at Kozloduy after a suspension in negotiations with Westinghouse. GOB will not commit to any state guarantees for any new nuclear projects and seeks a strategic investor to share risk.

Belene Project History and Overview: At the end of 2016, the National Electricity Company (NEK) paid EUR 601.6 M in damages to Atomstroyexport, the foreign contracts subsidiary of Russia's state nuclear

corporation Rosatom. Years ago Atomstroyexport was picked to build two 1000MW nuclear reactors at Belene site (on the Danube River), a project that was shut down by Bulgaria in 2012. The Russian contractor filed for arbitration, asking for EUR 1.2 B in damages for equipment ordered for the nuclear power plant, which NEK never paid for, and won the court action in June, although it was awarded just over half of the amount it claimed.

NEK has currently taken ownership of the equipment manufactured by Atomstroyexport, but uncertainty remains about what the company will do next. Bulgarian officials traveled to Iran earlier this year to discuss a possible sale of the equipment, but there has been no development in the months since then.

During an official meeting between Minister Petkova and the Alexey Likhachev, Director General, Rosatom State Corporation, Minister Petkova outlined GOB plans to spin off into a separate company the Belene assets, including the site itself and the equipment from Atomstroyexport, which would be put up for privatization.

The GOB is actively looking for a strategic investor for implementation of this project. In case such investor is not found, Bulgaria will consider the possibility for the manufactured Belene equipment to be utilized on the site of the future unit 7 at Kozloduy NPP. On behalf of Rosatom, Alexey Likhachev noted that there is an interest in participating in a possible implementation of the project as an EPC contractor.

The main activities in the nuclear energy field are safety operation of the existing two units, construction of up to two new reactors at Kozloduy, and construction of a dry spent fuel storage facility.

Public support for nuclear energy is strong in Bulgaria. In January 2013, a public referendum showed 61 percent of voters supporting the construction of a new NPP; however, turnout for the vote remained low—21 percent—making the vote non-binding but large enough to spark debate and discussion in Parliament. A January 2009 gas shortage prompted Bulgarian citizens to take to the streets in support of restarting reactors at Kozloduy. Political movements within Bulgaria have also tied nuclear energy to Bulgaria's emergence as a technologically advanced nation.

Planned and Potential Nuclear Energy Projects

New Build

Owner: State or shared

Reactor Type: PWR AP 1000 *Capacity:* 1,000MW

Capacity: 1,000 MWe

Value of Project: N/A

Construction Period: Not started – potentially 2020

Operation (tentative): 60 years

Kozloduy NPP: New Build EAD, the state-controlled project company, was granted permission by the Bulgarian Nuclear Regulatory Agency (NRA) to select the location of a planned nuclear generation facility. NRA official permission marks the beginning of the licensing procedure for the construction of a new NPP in Bulgaria. The project has been on hold since the March 2015 expiration of Westinghouse's Shareholder's Agreement with BEH. The GOB is seeking a strategic investor for the project.

Opportunities

Services (front-and back-end): Limited opportunities for decommissioning. Russian technology in Kozloduy 1-4 will pose challenges to U.S. companies to seeking to assist with decommissioning.

Legal and Consulting Services: Many opportunities exist. Several U.S. companies have consulted with the GOB on Belene NPP. Further opportunities exist for Kozloduy units 5 and 6's lifetime extension and plans for new construction. Bulgarian universities may benefit from assistance in educating and preparing nuclear engineers. GOB is also in the process of transitioning to an Integrated Management System at KNPP.

Licensing Support: The Bulgarian NRA is the only state body that can issue, amend, modify, renew, suspend and revoke licenses and permits for the safe conduct of NPP activities in Bulgaria.

Design, Construction, and Operation: Opportunities exist for new construction at Kozloduy (units 7 and 8), but new projects have been placed on hold following a breakdown in negotiations with Westinghouse.

Components: Moderate opportunities exist for operating plants. Reactor vessels, core, refueling machinery, turbines, storage equipment, etc. are manufactured in Russia.

Challenges and Barriers

Bulgaria's initial 2013 decision to sole-source Westinghouse for the Kozloduy extension project indicated significant potential opportunities for U.S. industry in this market, which has been difficult to enter due to its fleet of Russian reactors. Despite the failure of talks, the GOB remains hopeful that a deal can be reached with Westinghouse. Westinghouse has also asserted its commitment to continue discussing possible models for a Unit 7 at KNPP.

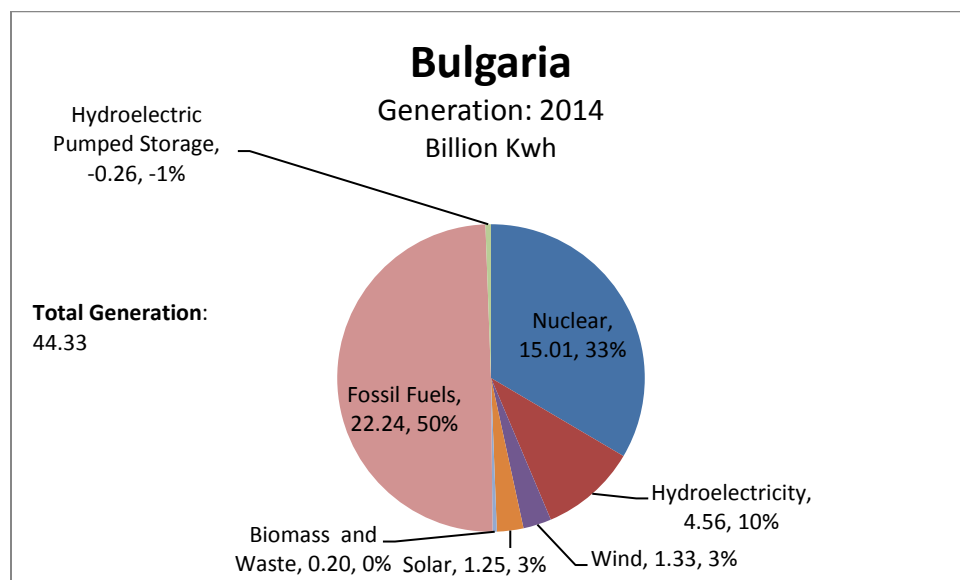
Financing new nuclear power projects is a key obstacle for Bulgaria. Bulgarian debt owed to the United States and other countries makes provision of EXIM Bank financing a challenge. Bulgaria also has a relatively low score on World Bank's Ease of Doing Business Indicators.

Nuclear Infrastructure

Research Reactor: The Institute for Nuclear Research and Nuclear Energy (INRNE) of the Bulgarian Academy of Sciences in Sofia operates Bulgaria's sole research reactor. The reactor's original capacity was 1 MWe in 1959 and was increased to 2 MWe in 1970, but the reactor was shut down in 1989. Currently, the reactor is being modified to operate on low enriched uranium (LEU) at a 2kW capacity. Bulgaria returned its highly enriched uranium (HEU) to Russia in 2003 and sent its used HEU and LEU in 2008.

Fuel: All front end fuel cycle services in Bulgaria are provided by Russia's TVEL through Technobexport.

Waste Management: State Enterprise Radioactive Wastes (SE-RAW) oversees the majority of Bulgaria's waste management. A 2002 agreement between Bulgaria and Russia established payment of USD 620,000 per ton of spent nuclear waste sent to Ozersk, Russia for reprocessing. Recent funds from the European Bank for Reconstruction and Development (EBRD) have enabled the construction of a dry fuel storage facility (DFSF) for 2800 VVER-440 used fuel assemblies near Kozloduy. Nukem Technologies and Gesellschaft für Nuklear-Service (GNSmbH) partnered to construct the facility. Current plans foresee expanding capacity to accommodate 8000 VVER-440 and 2500 VVER-1000 assemblies. The facility opened in May 2011 with the ability to store 5200 fuel assemblies in 72 casks. The Bulgarian government is also pursuing a national low and intermediate level waste disposal facility to be built on a site adjacent to Kozloduy.



U.S. Government Collaboration

123 Agreement: Nuclear cooperation between the United States and Bulgaria falls under the framework of the U.S.-EURATOM 123 Agreement, which expires in 2026 with rolling five-year extensions possible thereafter.

June 2013 Legal Review and Legislative Drafting Workshop: The U.S. Department of State’s Preventing Nuclear Smuggling Program (PNSP) and the Government of the Bulgaria organized a successful workshop in Sofia to assess how Bulgarian authorities would prosecute nuclear and radiological smuggling cases under existing criminal laws.

Technological Exchange: The U.S. Nuclear Regulatory Commission and Bulgaria’s NRA have an arrangement for the exchange of technical information and cooperation in nuclear safety matters.

U.S. Export Support: EXIM Bank supported U.S. civil nuclear exports to Bulgaria with a \$77 million facility in July 2000 for the safety upgrade of Kozloduy Nuclear Power Plant.

Regulatory Cooperation: The U.S. NRC and the Nuclear Regulatory Agency of the Republic of Bulgaria (NRA) an arrangement for the exchange of technical information and cooperation in nuclear safety and security matters. NRA has also signed agreements with the NRC to join the Code Applications and Maintenance Program (CAMP) and the Cooperative Severe Accident Research Program (CSARP).

International Engagement

Bulgarian Energy Holding Company (BEHC)—a 100 percent state owned energy holding company—reached an agreement with France’s AREVA in April 2011 as part of Bulgaria’s commitment to developing low-carbon energy projects. The memorandum of understanding (MOU) identifies plans for cooperation on new nuclear projects at the Kozloduy (existing) and Belene (proposed) sites. The agreement also identifies fuel management policies and responses, such as spent fuel recycling as well as meeting international standards of nuclear safety. The agreement with AREVA provides BEHC access to AREVA’s portfolio of Generation III nuclear reactors.

GOB has demonstrated a commitment to reducing GHG emissions by ratifying the United Nations Framework Convention on Climate Change and the Kyoto Protocol to the Convention. Modernizing and upgrading KNPP Units 5 and 6 are recognized as an important component in the GOB’s plans to reduce GHG emissions.

Figure 7: Additional Agreements

Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓

Joint Convention on Safety of Spent Fuel Management	✓
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	
Paris Convention on Third Party Liability in the Field of Nuclear Energy	
Vienna Convention on Civil Liability for Nuclear Damage	✓
Joint Protocol Relating to the Application of the Vienna Convention and Paris Convention	✓
Convention on Supplementary Compensation for Nuclear Damage (CSC)	
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	✓
OECD/NEA	
IFNEC	✓
GenIV International Forum (GIF)	
EURATOM	✓

Resources

For more information on the commercial opportunities in Bulgaria, contact: Maria Galindo (Senior Commercial Officer in Sofia, maria.galindo@trade.gov) Emily Taneva (Commercial Specialist in Sofia, emily.taneva@trade.gov).

For more information on nuclear energy in Bulgaria, see: Bulgarian Energy Holding:
<http://www.bgenh.com/>

Sources

CIA Factbook, United Nations, World Nuclear Association, Asian Development Bank, and contacts at U.S. Embassy Sofia.

Canada

Market Type: Mature and Maintaining

While Canada has delayed plans to build additional domestic reactors, it is a competitor of the United States in international markets. Canada's ongoing decommissioning and refurbishing projects offer some opportunities for U.S. exporters, although a robust Canadian nuclear industry and lower electricity demand will limit U.S. participation in new large reactor builds. To satisfy electricity demand in the long term, the Canadian utility Saskpower is studying small modular reactors (SMRs), and Canada's Chalk River National Laboratory hopes to deploy an SMR by 2026. Both have requested the help of U.S. expertise in SMRs. Canada is also home to several Generation IV reactor companies.

Overall
Rank

#11

U.S. Ambassador to Canada: Bruce A. Heyman

U.S. Commerce Attaché to Canada: Lucy Latka

Market Overview

Canada is home to 19 nuclear reactors, which provide approximately 16 percent of Canada's electricity generation. The Canadian nuclear industry is a \$6.6 billion industry and is a global leader in uranium mining and fuel supply, reactor exports and medical isotope production. On June 6, 2017, Canada ratified the Convention on Supplementary Compensation for Nuclear Damage (CSC).

The four main reactor sites are Bruce Power Nuclear Generating Station (NGS) on Lake Huron (190 km from Toronto), Darlington NGS on Lake Ontario (60 km from Toronto), Pickering A NGS on Lake Ontario (30 km from Toronto) and Point Lepreau NGS in New Brunswick (30 km southwest of Saint John).

All of Canada's operational reactors are CANDU (Canadian Deuterium Uranium) PHWR-type reactors designed by Atomic Energy Canada Ltd (AECL) of Mississauga, ON, in cooperation with GE. GE also supplies reactor systems, including the radioactive combustible loading/unloading in the reactor.

In October 2011, the commercial reactor business of AECL was sold to SNC-Lavalin, which established Candu Energy Inc. as a subsidiary. The federal government continues to own and operate other parts of AECL, including the research reactors, mainly the Chalk River facilities, under the name of Canadian Nuclear Laboratories (CNL), which are managed by a consortium called Canadian Nuclear Energy Alliance (CNEA). CNL recently released an aggressive long term strategy with \$1.2 billion of investment over the next ten years in the Chalk River facilities, to include the construction of an Advanced Nuclear Materials Centre; demonstration of a new advanced fuel concept by 2020; and the siting of an SMR by 2026, among other highlights.

Canadian reactors are undergoing an extensive refurbishment program aimed at enhancing safety, uprating, and extending operational lifetime. To date, seven reactors have completed refurbishment. Large cost overruns and schedule delays with several of these projects have caused operators and investors to reevaluate plans for other reactors, resulting, in some cases, in scaling down the extent of refurbishment or shutting down plants rather than refurbishing them. Plans for refurbishing reactors at Pickering B, Bruce B and Darlington, are under review and may extend over the next ten years. In December 2015, the Ontario Energy Ministry announced the approval of the long-term contract that will allow Bruce NGS to refurbish six reactor units. Bruce Power will invest CD\$13 billion to refurbish the plants. In January 2016, the Ontario Energy Ministry approved Ontario Power Generation's plans to refurbish two nuclear reactor units at Darlington NGS.

Three reactors are undergoing decommissioning. The extent of other opportunities for decommissioning contracts will depend on plans for refurbishing Canada's remaining three currently shut down reactors. The decommissioning of Gentilly 2 has begun a 4-step process: following the conclusion of the "stabilization" phase in 2014, the plant is currently in the "dormancy preparations and fuel transfer" stage until 2020, at which time it will enter the "dormancy and surveillance" stage for 33.3 years to be followed by dismantling and site restoration. Of those units that have already undergone refurbishment, the first planned closure will occur in 2018.

Canada has largely deferred its new reactor builds due to slow electricity demand growth. In November 2013, the Ontario government indefinitely deferred plans for constructing two new reactors at Darlington. The leading contenders for the new reactors were Westinghouse (AP1000) and SNC-Lavalin/Candu Energy Inc. (Enhanced Candu-6 (EC6)); both had submitted detailed construction plans, schedules and cost estimates before the decision to defer construction plans was made.

Additional plans for reactor projects have been pursued by the governments of New Brunswick, Saskatchewan, and Alberta over the last ten years. The Saskatchewan utility Saskpower is studying SMRs for deployment in Saskatchewan in the long term, and the utility has said SMRs could be a "game changer" for the province. It is unlikely that Alberta will consider constructing a nuclear plant in the province while oil prices remain low. New Brunswick has also deferred its plans.

Canada continues to market CANDU reactors abroad in both newly emerging and mature markets; such potential new builds present opportunities for U.S. industry engagement.

Planned and Potential Nuclear Energy Projects

New Build

Owner: Ontario Power Generation (OPG) (government-owned crown corporation)

Reactor Type: undetermined

Capacity: up to 4800 MWe

Value of Project: N/A

Construction Period: indefinitely deferred in November 2013

Operation (tentative): N/A

Notes: The project has been deferred in favor of refurbishing existing plants through 2026. Reactor projects at Point Lepreau in New Brunswick and Peace River in Alberta have been proposed but have not moved forward.

Refurbishments

Owner: OPG

Reactor Type: two CANDU reactors and related facilities at Darlington NGS

Value of Project: CD\$13 billion

Construction Period: start 2016

Owner: Bruce Power

Reactor Type: six CANDU reactors at Darlington NGS

Value of Project: CD\$13 billion

Construction Period: start 2020

Opportunities

Services (front- and back-end): Opportunities for decommissioning. Additionally, engineering, fuel services, and waste management – including transportation of fuel and waste – present good opportunities for U.S. companies. Canada’s planned refurbishments will also create an opportunity for U.S. companies.

Legal and Consulting Services: Limited.

Licensing Support: Limited.

Design, Construction, and Operation:

Opportunities exist for U.S. content in CANDU new build abroad, but there are no new build plans in Canada.

Components: Significant opportunities will exist for U.S. component manufacturers due to the announced refurbishments of existing plants in Canada and moderate opportunities for CANDU reactors abroad.

Mandated country-wide carbon tax may incentivize nuclear power: Canada’s current liberal government, while still supportive of fossil fuel development, has expressed a commitment to reduce greenhouse gas emissions and has mandated a country-wide carbon tax across the country by 2018. Canada is the first major hydrocarbon producer in the world to launch such an aggressive plan. In the long term, this may incentivize utilities to pursue lower-emitting sources of electricity, such as nuclear power.

Challenges and Barriers

New Builds: The main barrier for new build contracts in Canada is the stagnant demand for electricity and more than sufficient existing capacity. The Ontario government cited low projected electricity demand as the reason for deferring plans for the Darlington expansion project. Canada's vast reserves of natural gas and low domestic natural gas prices further dampen demand for new nuclear capacity. Furthermore, Canada's abundant hydroelectric resources provide strong competition for new nuclear capacity. It is unclear how Canada's projected reactor retirements will impact its new build plans.

If new construction is pursued, at this time, it would be difficult for a supplier other than Candu Energy to win new build contracts because of the confidence that has developed from Candu Energy's history in the Canadian market. Candu Energy and its parent, SNC-Lavalin, have access to high-level decision makers in the provincial and federal governments and it is the largest EPC company in Canada.

Components: The integration between the U.S. and Canadian civil nuclear industries for goods and services creates more opportunities for U.S. suppliers in Canada. Opportunities also exist for U.S. content in CANDU reactors third countries, including upgrades to operating plants and new builds.

Other Barriers: Canada remained on USTR's Special 301 Watch List in 2015, mainly due to border enforcement issues of pirated and counterfeit goods and for patent regulation issues chiefly related to the pharmaceutical industry. Canada scores highly in all financial and infrastructure factors, and its commitment to accede to the CSC is welcome news.

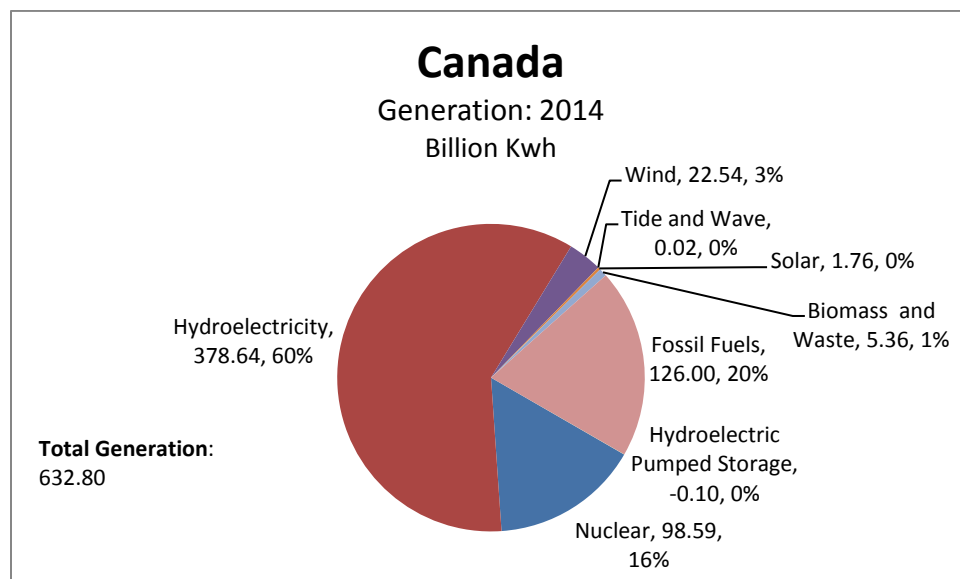
Nuclear Infrastructure

Research Reactor: A 60 MWe WR-1 research reactor was built by GE at Whiteshell Laboratories and started up in 1965. The original purpose of the unit was a test reactor for a proposed organic-cooled CANDU power reactor. When that program ceased in 1972, it was used for other R&D until it was shut down in 1985. Six other research reactors were built and continue to operate on university campuses. Five of these are SLOWPOKE-2 units, low-energy pool-type reactors designed by AECL with passive cooling and safety systems.

Fuel: Canada is the world's second largest exporter of uranium, accounting for 15 percent of world output, and 15 to 20 percent of Canadian uranium production is consumed domestically. All Canadian uranium mining currently takes place in northern Saskatchewan. Cameco Corporation and AREVA Canada Resources Inc. (AREVA) are the majority owners and operators of the uranium mines and mills now in operation. Cameco owns and operates the Rabbit Lake mill and the Eagle Point mine. It is also the joint venture operator of the McArthur River mine and the Key Lake mill. AREVA is the operator of the McClean Lake mine and mill.

At its Port Hope, Ontario facility, Cameco has about one-quarter of the Western world's uranium hexafluoride (UF6) conversion capacity and provides the only commercial supply of fuel-grade natural (unenriched) uranium dioxide (UO2). The UF6 is enriched outside Canada for use in light water reactors, while natural UO2 is used to fabricate fuel bundles for CANDU reactors in Canada and abroad. Two fuel fabrication plants in Ontario process some 1,900 tons of uranium per year to UO2 fuel pellets, mainly for domestic CANDU reactors.

Waste Management: Canada's nuclear regulator is the Nuclear Fuel Waste Bureau from Natural Resources Canada. The Nuclear Waste Management Organization (NWMO), together with Candu Energy, is responsible for storage and disposal of high-level wastes. Nuclear utilities and AECL are responsible for low and intermediate-level wastes. A deep geological repository for high-level wastes is currently under advanced approval process for Tiverton, ON with input/approval from host communities. NWMO expects the repository to begin operation in 2035. Low and intermediate-level wastes are stored above ground. A Deep Geologic Repository is in the planning stage and is subject to further approval.



U.S. Government Collaboration

123 Agreement: Canada's 123 Agreement with the United States expires on January 1, 2030, with rolling five-year extensions thereafter.

Implementing Arrangement (IA): The Department of Energy, the Department of Natural Resources of Canada, and the Atomic Energy of Canada, Ltd., signed an IA for collaboration in the area of nuclear research and development on January 13, 2015.

U.S.-Canada Action Plan: In June 2017, DOE's Office of Nuclear Energy signed an Action Plan with Canada's NRC and Atomic Energy Canada Limited to pursue joint R&D in reactor technologies; light and heavy water reactor sustainability; advanced fuel and fuel cycles; and modeling and simulation.

Regulatory Cooperation: The U.S. NRC and the Canadian Nuclear Safety Commission (CNSC) have an arrangement for the exchange of technical information and cooperation in nuclear safety and security matters. CNSC has also signed agreements with the NRC to join the Code Applications and Maintenance Program (CAMP) and the Cooperative Severe Accident Research Program (CSARP).

International Engagement

On January 24, 2017, Terrestrial Energy USA informed the U.S. NRC of its plans to begin pre-application interactions to eventually license its Integral Molten Salt Reactor (IMSR) in the U.S.; Terrestrial Energy intends to submit its license application to the NRC in late 2019. Ontario-based Terrestrial Energy began its licensing process with the Canadian nuclear regulator in early 2016.

The GOC cooperates with many countries for R&D and commercial engagement and promotion. In July 2014, SNC-Lavalin signed two cooperation agreements with China National Nuclear Corporation (CNNC) to jointly develop reactors using CANDU technology and to collaborate on uranium mining projects in China. The GOC is active in multilateral organizations, including the IAEA and IFNEC.

In April 2015, Cameco signed a uranium supply contract with India's Department of Atomic Energy. Its first shipment arrived in December, ending a bilateral nuclear cooperation hiatus that lasted over 41 years.

Figure 9: Additional Agreements	
Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	✓
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention on Third Party Liability in the Field of Nuclear Energy	
Vienna Convention on Civil Liability for Nuclear Damage	
Joint Protocol Relating to the Application of the Vienna Convention and Paris Convention	
Convention on Supplementary Compensation for Nuclear Damage	✓
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	✓
OECD/NEA	✓
IFNEC	✓
GenIV International Forum (GIF)	✓
EURATOM	

Resources

For more information on commercial opportunities in Canada, contact: Stefan Popescu (Commercial Specialist in Toronto, stefan.popescu@trade.gov); Cindy Biggs (Principal Commercial Officer in Calgary, cindy.biggs@trade.gov).

For more information on nuclear energy in Canada:

Atomic Energy of Canada Ltd: <http://www.aecl.ca/en/home/default.aspx>

Canadian Nuclear Safety Commission <http://nuclearsafety.gc.ca/eng/>

Sources

CIA Factbook; Energy Information Administration (EIA); United Nations; World Nuclear Association; Asian Development Bank, and our contacts at the US Embassy in Ottawa and the US Consulate in Toronto.

China

Market Type: Existing and Expanding

China is aggressively expanding its nuclear fleet to reduce air pollution from coal-fired power plants and keep pace with economic growth, but electricity demand growth slowdowns have partially delayed new reactor construction. While technology indigenization, local content requirements and self-sufficiency limit foreign participation, nuclear sector growth in the next decade will ensure commercial opportunities for U.S. civil nuclear exporters. China has an aggressive nuclear export strategy that includes offering financing.

Overall
Rank

#2

Chargé d’Affaires ad interim: Jonathan Fritz

Market Overview

China has 37 operational nuclear reactors and 21 under construction, totaling just over 53 GWe of nuclear capacity. China ranks first in the world for number of units under construction. From the beginning of 2016 through June 2017, seven new nuclear reactors were connected to China’s grid.

In October 2012, China’s former Premier, Wen Jiabao, outlined a post-Fukushima approach to nuclear power development, which consists of China employing a steady pace in its effort to build new nuclear power plants (NPPs) while complying with new generation safety standards. In recent years, China has reduced its nuclear capacity target to 58 GWe by 2020 from the previous goal of 80 GWe. Although construction progress in recent years has lagged behind the pace required to meet the 12th Five Year Plan’s (FYP) stated goal of 58 GWe installed capacity by the end of 2020, this target has remained unchanged in the 13th FYP (representing a doubling of the 2015 installed capacity).

China's 13th FYP also laid out goals for accelerating the nuclear power program, which includes explicit directives regarding certain key reactor projects. Additional initiatives that aim to build on the growing momentum were also laid out. The accelerated construction of Tianwan Phase III timeline and a new batch of coastal power plants to be constructed at a site as-yet undeclared are specifically identified.

During the 13th Five-Year Plan (2016-2020), China will focus on constructing coastal NPPs; building indigenous nuclear demonstration projects; completing Sanmen and Haiyang AP1000 projects; building Fuqing and Fangchenggang Hualong One demonstration projects; starting construction of Rongcheng CAP1400 demonstration project; accelerating construction plans for Tianwan units 5 and 6; active preparation of inland NPPs; accelerating and facilitating large commercial reprocessing plant construction; and strengthening its nuclear fuel security system.

Of the four Westinghouse AP1000 reactors that are under construction in China: Sanmen-1 & 2 and Haiyang-1 & 2; the cold hydrostatic and hot functional testing have been completed on the Sanmen-1

and Haiyang-1. Fuel has been delivered to both locations, but is awaiting fuel loading permits from China's National Nuclear Safety Administration (CNNSA). The Sanmen nuclear power site will be the first AP1000 reactor in the world to become operational at the end of 2017 or early 2018. Six more AP 1000 reactors at three sites are planned: Sanmen 3&4, Haiyang 3&4, and Lufeng 1&2.

China is considering restructuring its energy industry by creating three large power companies through consolidation of eight coal and nuclear generating entities with assets in excess of \$855 Billion USD to reduce debt held by its state-owned power companies by pairing them with financially stronger companies, to reduce industrial overcapacity, and to reduce its reliance on coal.

China also aims to become a reactor design exporter and compete alongside established companies for reactor tenders worldwide. Its policy of indigenizing foreign technology, though helping to expand China's reactor design and engineering capabilities, has thus far limited China's ability to export its designs, as its technology transfer agreements—with Westinghouse for the AP1000, for example— forbid China from exporting indigenized designs below a specified power threshold. China has recently developed two designs for export: the ACC1000 (also known as the Hualong One, a recent merger of the ACP1000 and ACPR1000 designs) and the CAP1400, which is based on the Westinghouse AP1000 model but scaled to a power capacity allowing China export rights. China National Nuclear Corporation (CNNC) and China General Nuclear (CGN) signed a joint venture to promote the Hualong One and export Generation III reactors globally.

In January 2015, China announced an incentive and financial program for nuclear exports. A few months later, an agreement was signed with Argentina to build two reactors mostly financed by China. The first reactor is a Candu type reactor to be delivered in 2016 while the second is a Hualong One reactor.

China is supporting civil nuclear projects in the UK, including CGN's 33.5 percent ownership in the Hinkley Point C site and 20 percent ownership in the EDF-controlled Sizewell site. EDF's European Power Reactor (EPR) is to be built at both sites. In exchange for Chinese funding, EDF will take a 33.5 percent stake in the Bradwell site, where the Chinese designed Hualong One reactor will be built. This will be the first Chinese-designed reactor to be built in a Western country.

China has a vast R&D portfolio that includes all aspects of the fuel cycle. It is pursuing fast reactor, HTGR, and SMR demonstration projects, as well as expanding its capabilities for uranium mining, enrichment, fuel fabrication and reprocessing. In nearly all of these areas, China is developing its technology as well as partnering with foreign governments and industry to import technology.

Commercial Opportunities

Services (front-and back-end): Opportunities for probabilistic risk assessment and regulatory advisory services.

Licensing Support: Opportunities exist to support China's National Nuclear Safety Administration (NNSA).

Design, Construction, and Operation: Significant opportunities for new nuclear plant construction.

Components: The interim portion of the NPP supply chain represents the largest current opportunity for U.S. exporters. Despite the constant push for increased local content in Chinese plants, foreign suppliers continue to find opportunities in the Chinese nuclear space. While balance-of-plant and conventional island equipment are primarily supplied by domestic vendors, certain key nuclear island technologies have been slower to localize, especially nuclear safety class components.

Under China's mammoth nuclear energy expansion, China is building plants of two basic types. The first are Generation II reactors based on technology already mastered by Chinese domestic producers. The second are Generation III reactors for which China is still largely dependent on foreign suppliers. Currently, China plans to manufacture 50 to 60 percent of the units domestically, based on the older Generation II technology, leaving 40 to 50 percent of the market for Generation III nuclear equipment imports, an estimated \$15 billion in market value. In the downstream market, similar to the interim market, the quality of products produced by most Chinese domestic manufacturers does not meet the demand of Chinese buyers. The best prospects for U.S. exporters in the downstream market are nuclear pumps and valves, breakers, large forging parts and other accessories.

Third Country: U.S. firms may find opportunities to collaborate with Chinese companies in overseas markets, particularly as China begins building its indigenous reactor models.

Fuel Management: China is not fully self-sufficient in the upstream market for raw materials used in NPPs. Chinese mines produce 70 percent of the uranium used in Chinese reactors. Chinese imports of U.S. graphite moderator rods recently increased. China is now the third largest buyer, after Japan and Canada, of U.S. graphite. Moreover, China lacks expertise in the fuel cycle and is struggling to resolve bottlenecks in the industry, including fuel processing and waste recycling.

Challenges and Barriers to Exports

Local content requirements: China has an explicit policy of technology transfer, and it has become increasingly self-sufficient. It has gained experience in constructing new reactors and other fuel cycle facilities, to the effect that new reactor builds in the near future may contain as much as 85 percent local content. Strong foreign competition is also a challenge and will limit market access for U.S. industry. Nonetheless, the size of China's market is so large and the pace with which it is building new reactors and facilities is so swift that China will remain a strong and dynamic market for U.S. exports for years to come for all areas of the civil nuclear sector.

Public Opinion: While government support is strong mainly due to intense pressure to find new sources of clean electricity, public opinion regarding nuclear energy in China is complex. A few cases of public

opposition to new nuclear plants have caused delays or halts to planned projects, most noticeably with the postponement of construction at new inland sites. However, strong public sentiment toward achieving clean air goals may make the public more supportive of nuclear energy.

Liability: China has not committed to signing the CSC to date. With Japan's ratification and the CSC entry into force, the Chinese government officials have indicated an interest in revising their current national law to make it consistent with the CSC.

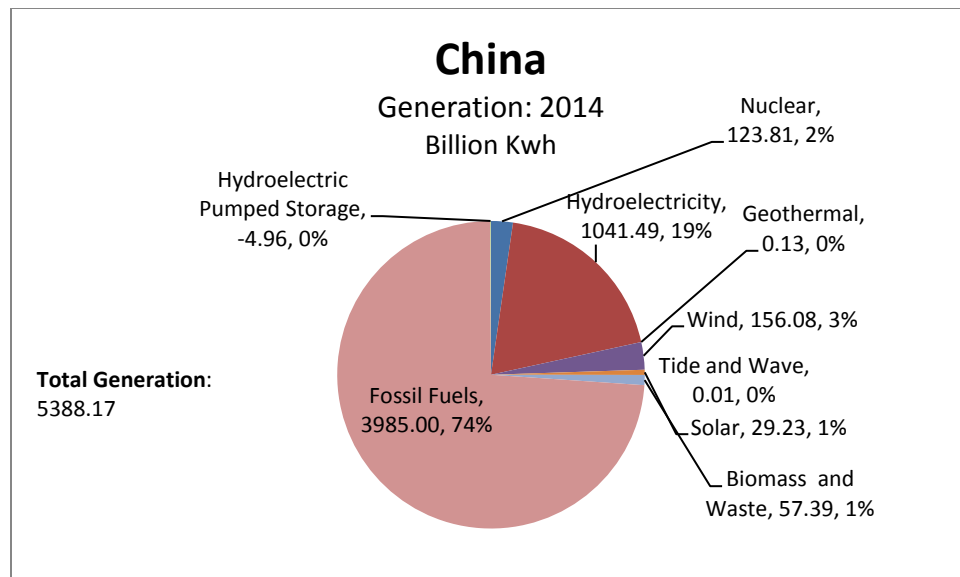
HAF604 Certification: China applies HAF604 registration to foreign companies, which is required for foreign companies to be able to design, manufacture or install imported safety-related nuclear equipment, or perform nondestructive examination (NDE) for nuclear safety equipment. Obtaining HAF604 certificate is a significant barrier to entry for the Chinese civil nuclear safety equipment market. The procedure for applying, supporting, and confirming a HAF604 registration takes between 10-16 months and requires the applicant to prepare a comprehensive set of application documents in Chinese.

Nuclear Infrastructure

Research Reactor: China has 17 operational research reactors. The China Institute of Atomic Energy (CIAE) is the leading organization for basic nuclear science research and runs the China Experimental Fast Reactor.

Fuel: CNNC is responsible for domestic production and overseas development of uranium. More than 2 million tU of potential resources have been identified in China, but current production (1,800 tU per year) cannot meet China's current and future needs. Even with increased production, China will need foreign imports to meet demand. China imports uranium from a variety of countries, mainly Kazakhstan, Canada and Australia, and has acquired equity in uranium mines in Kazakhstan, Namibia, Niger and Uzbekistan.

Waste Management: A centralized fuel storage facility has been built at Lanzhou Nuclear Fuel Complex. Regional storage centers are under development. Construction on a geological repository is planned for 2040 to open by 2050. Site selection is currently underway.



U.S. Government Collaboration

123 Agreement: A new 123 Agreement with the United States entered into force on October 29, 2015 and expires in October 2045. This replaces the 1985 agreement.

Peaceful Uses of Nuclear Technology (PUNT) Agreement: United States and China meet annually on nonproliferation and nuclear energy cooperation topics, including joint work on probabilistic risk assessment training for Chinese operators.

Civil Nuclear R&D Cooperation: U.S. DOE-China Peaceful Uses of Nuclear Technology (PUNT) Agreement: In 1998, DOE and China signed the “Agreement between the Department of Energy of the United States of America and the State Development Planning Commission of the People’s Republic of China on Cooperation Concerning Peaceful Uses of Nuclear Technologies” (PUNT). Since 1998, six working groups have formed under the PUNT Agreement dedicated to activities focused on nonproliferation, nuclear energy technology and safety, and issues pertaining to the current fleet reactor technologies.

U.S. DOE-China Bilateral Civil Nuclear Energy Cooperative Action Plan (BCNECAP): In 2007, separate from PUNT, DOE and China’s National Development and Reforming Commission (NDRC) signed an agreement for an action plan for bilateral cooperation in the development of advanced nuclear technologies, fuels and materials development, nuclear safety enhancement; spent fuel storage and repository science, and high temperature gas reactor technologies.

May 2013 Trade Mission: In May 2013, then DOC Under Secretary for International Trade led a delegation of senior U.S. government officials from DOC, DOE, Ex-Im Bank, and U.S. industry to work with the Chinese government counterparts on U.S.-China nuclear power cooperation.

Regulatory Cooperation: The U.S. NRC and the National Nuclear Safety Administration of the People's Republic of China (NNSA) have an arrangement for the exchange of technical information and cooperation in nuclear safety and security matters. NNSA has also signed agreements with the NRC to join the Code Applications and Maintenance Program (CAMP) and the Cooperative Severe Accident Research Program (CSARP).

International Engagement

China has extensive international engagement seeking to market its civil nuclear services worldwide and has civil nuclear cooperation agreements with many countries. To date, the arrangements with Pakistan have resulted in actual construction. China signed an agreement with Areva and EDF in 2013 on reactor development and is taking partial ownership of the planned reactors at Hinkley Point in the UK. In November 2013, Romanian Nuclearlectrica (SNN) signed two agreements with CGN for nuclear cooperation, including a letter of intent to construct two reactors units, and in May 2014, the Romanian prime minister announced that the Industrial and Commercial Bank of China will fund the projects. Further agreements with Romania were signed in 2014, 2015, and 2016 and negotiations continue to form a joint venture company with CGN and SNN. China has also signed MOUs with Egypt, South Africa, Kenya, Argentina, Saudi Arabia, and Turkey. On April 23, 2017, CNNC signed the first commercial contract for reconstruction of Iran's Arak heavy water reactor and consulting services. Domestically, China recently signed a deal with Russia for more VVERs at Tianwan and for fast breeder reactors. U.S. company TerraPower signed an agreement with CNNC in Beijing on global business cooperation and WEC aims to be a part of the consortium development of Turkey's third proposed nuclear power plant.

In the fuel services area, China's nuclear companies have signed agreements with Canada for advanced fuel development, with Kazakhstan for nuclear power in each country, and expanded ownership in uranium mines in Africa.

Figure 9: Additional Agreements	
Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	✓
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention on Third Party Liability in the Field of Nuclear Energy	
Vienna Convention on Civil Liability for Nuclear Damage	
Joint Protocol Relating to the Application of the Vienna Convention and Paris Convention	
Convention on Supplementary Compensation for Nuclear Damage	
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	✓
OECD/NEA	
IFNEC	✓
GenIV International Forum (GIF)	✓
EURATOM	

Resources

For more information on commercial opportunities in China, contact: Christian Koschil (Commercial Officer in Shanghai, Christian.Koschil@trade.gov), Scott Yao, Senior Commercial Specialist in Shanghai (scott.yao@trade.gov), Bradley Harker, Commercial Officer in Beijing (Bradley.Harker@trade.gov).

Sources

CIA Factbook; Energy Information Administration (EIA); United Nations; World Nuclear Association; Asian Development Bank, and our contacts at the US Embassy in Beijing and the US Consulate in Shanghai.

Czech Republic

Market Type: Existing Market

The Czech Republic has six operating nuclear reactors and plans to build at least two additional units. Despite the April 2014 cancellation of a tender for new reactors, the Czech government has quickly signaled its intention to continue developing its nuclear industry. Financing and recent policy uncertainty regarding energy subsidies are the main challenges to U.S. exports, along with competition for new builds from Russia, China, and South Korea.

Overall
Rank

#7

Chargé d’Affaires to Czech Republic: Kelly Adams-Smith
U.S. Commerce Attaché to Czech Republic: Helen L. Peterson

Market Overview

The Czech Republic currently has six operating nuclear reactors, all Russian-designed. Four reactors (model: VVER-440 V-213) are located at the Dukovany Nuclear Power Plant (NPP) and two (model: VVER-1000 V-320) are located at the Temelín NPP. The majority state-owned Czech Energy Works (ČEZ) owns and operates both plants.

In 2009, ČEZ issued a tender for two new reactors at Temelín. ČEZ canceled the tender in 2014 due to the Prime Minister stating that the government would not provide electricity rate guarantees.

Following the Temelín tender cancellation, the Czech government quickly reiterated its interest in nuclear power and in June 2015 approved a Czech National Action Plan (NAP) for Nuclear Energy and the State Energy Plan (SEP). The plans call for nuclear power to increase from the current 30 percent to 50 percent of electricity generation by 2035. Subsequently, in the fall of 2015, the government announced its intention to develop the first nuclear unit at Dukovany due to the necessity to replace the four reactors at the site by the mid-2030s. There is a possibility that the government will develop a further three units at both Dukovany and Temelín, but at present, there is no timeline for these projects. In the summer of 2016, the Ministry of Industry and Trade (MOIT) and ČEZ issued a Request for Information (RFI) for a new unit at Dukovany to nine companies from six countries. Six companies responded, providing both technical information and financing proposals. In January-February 2017, the government and ČEZ reviewed the proposals and held discussions with the six companies. Further developments are not anticipated until a new government is in place after parliamentary elections in October 2017. Financing remains an issue, given the large disparity between current wholesale electricity rates and the estimated break-even cost of any nuclear project.

All Dukovany and Temelín units have undergone upgrades in the past ten years, and further upgrades are under consideration. ČEZ is seeking license extensions to the four Dukovany units between 2015 and 2018. While experts indicate ten-year extensions should be fairly routine (to the mid-2020s), there is

greater uncertainty whether subsequent extensions will be granted without major and costly upgrades, especially in cabling.

Planned Nuclear Energy Projects

Owner: Czech Energy Works
Site: Dukovany
Reactor Type: PWR
Capacity: 1x 1200+ MWe
Value of Project: N/A
Construction Period: 2025-2034
Operation (tentative): 2035-2039

Owner: Czech Energy Works
Reactor Type: PWR
Site: Temelín
Capacity: 1x 1200+ MWe
Value of Project: N/A
Construction Period: 2025-2034
Operation (tentative): 2035-2039

Dukovany Plant Extension: ČEZ is seeking extensions to the mid-2030s for the four existing Dukovany VVER-440 reactors. The first two reactors have been granted indefinite extensions dependent on meeting certain performance metrics; the others are likely to receive extensions in 2017 and 2018.

Temelín Expansion: Currently there is no timeline for new units at the Temelín site.

Radioactive waste management: Proposed construction to start in 2050 and be in operation from 2065.

Opportunities

Design, Construction, and Operation: Early in 2017, ČEZ held talks with six companies and consortia interested in building a reactor at Dukovany: Westinghouse, Rosatom, EDF, Areva-Mitsubishi Heavy Industries (Atmea); China General Nuclear Power Corp (CGN); and Korea Hydro and Nuclear Power (KHNP).

Fuel Management: The European Union strongly encourages multiple fuel suppliers for both technical and political security reasons. Until 2020, both the Dukovany and Temelín plants will be supplied with nuclear fuel from Russia's TVEL. Westinghouse fuel assemblies are now being tested at Temelín ahead of a fuel tender planned for 2018.

Development of new technologies: The Czech government has been working with the U.S. in the research and development of small modular reactors (SMRs) and hopes to implement the technology by

the late 2020s. In late 2016, Czech officials signaled their desire to deepen cooperation with the United States in the development of SMRs.

Challenges and Barriers

Financial challenges are the main obstacles to civil nuclear exports to the Czech Republic. Westinghouse's success in being selected as a participant in the Dukovany RFI has shown that U.S. industry can be highly competitive in this market. Market access relating to the country's existing fleet is limited due to the preponderance of Russian-designed reactors. Public opinion toward nuclear power, however, has remained favorable in recent years.

Moreover, the government has signaled its intention to develop its nuclear industry. In January 2016, as directed by the National Action Plan (NAP), the government created an interagency coordinating committee for nuclear energy under the Prime Minister. In January 2017, three working groups were created as part of the Standing Committee for Nuclear Energy; each of working group is responsible for determining financial, legal, and technical investment strategies. At the Standing Committee's January 2017 meeting, the group agreed to continue making changes to the licensing process to make it more efficient and noted that they are talking to the EU about how to more effectively select a vendor for future new builds. New construction, supply chain, waste management and nuclear-related legislation will be centered in this new committee. Furthermore, the country's 2015 State Energy Plan repeated earlier commitments for reactor construction, anticipating reactors at Dukovany and Temelín. In May 2017, a team of International Atomic Energy Agency (IAEA) experts determined that the Czech Republic has significantly improved its regulatory framework for nuclear and radiation safety as a result of the enforcement of the Atomic Act at the beginning of 2017.

Financial challenges remain an issue as the Czech government is unwilling to provide financing guarantees. It has reached out to foreign partners, including the United States and Russia, for assistance in financing new nuclear reactors. Financing pledges by technology providers will likely be an important component in future tenders which could confer a significant advantage on state-owned enterprises.

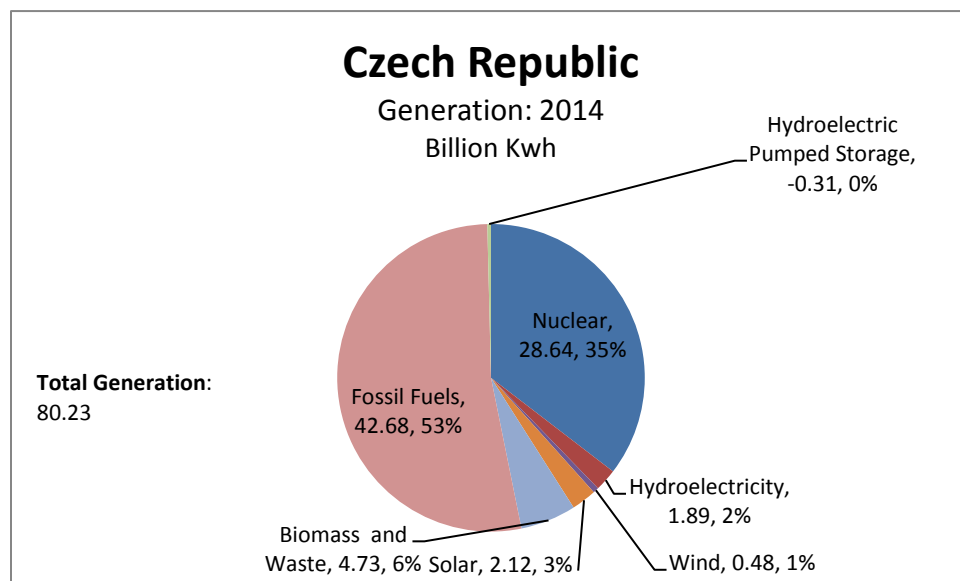
Nuclear Infrastructure

Research Reactor: The Řež Nuclear Research Institute currently has two research reactors in operation, and the Czech Technical University in Prague operates a third research reactor.

Fuel: Fuel for Dukovany and Temelín are both supplied by TVEL, though Temelín was supplied by Westinghouse until 2010. In 2016, Westinghouse won a contract to supply six test assemblies for evaluation over a two-year period at Temelín with the intent of bidding for a new contract in 2018. This would allow the Czech Republic to better meet EU requirements for diversity in fuel supply options. The Czech Republic's mine at Rožná—the only operational uranium mine in Central Europe—is nearing

depletion and likely to close in 2017. The Czech government is considering reopening a uranium mine near Jihlava, which is estimated to have 3,000 to 4,000 tons of uranium ore.

Waste Management: Used fuel storage and management is the responsibility of ČEZ until it is handed over to the Radioactive Waste Repository Authority (RAWRA) for storage in one of three interim dry-storage facilities. RAWRA is in charge of siting and building a high-level waste repository; an agreement was signed between RAWRA and a Finnish firm in October 2016 who will advise in the site selection process for a repository, as well as the disposal concept and repository design, with the selection of a final site expected by 2025. Construction will start after 2050 with operation beginning in 2065.



U.S. Government Collaboration

123 Agreement: Nuclear cooperation between the United States and the Czech Republic falls under the framework of the U.S.-EURATOM 123 Agreement; it will expire on April 12, 2026, with rolling five-year extensions thereafter.

Joint Declaration on Civil Nuclear Commercial Cooperation: In December 2010, the Department of Energy (DOE) and the Department of Commerce (DOC), together with the Czech Ministry of Industry and Trade (MOIT), signed a Joint Declaration Concerning Industrial and Commercial Cooperation in the Nuclear Energy Sector.

R&D Agreement: The Department of Energy and the Ministry of Industry and Trade concluded an agreement on cooperation in civil nuclear energy research and development in March 2014.

Civil Nuclear Cooperation Center: In 2014, the United States supported the establishment of a Civil Nuclear Cooperation Center in Prague through contributions to the International Atomic Energy Agency’s (IAEA) Peaceful Uses Initiative for regional activities to be performed in collaboration with the Centre, including R&D workshops, seminars, training activities and academic exchanges. Initially operated from the Czech Technical University, in 2016, it moved to the Nuclear Research Institute at Řež.

U.S.-Czech Technical Cooperation Arrangement: The NRC and the Czech Republic State Office for Nuclear Safety (SÚJB) are signatories to this arrangement, which was renewed at the 2014 International Atomic Energy Agency’s General Conference.

U.S.-Czech Implementing Agreement: The NRC and Czech Republic State Office for Nuclear Safety (SÚJB) are signatories to a 1999 Implementing Agreement Relating to Participation in the USNRC Program of Severe Accident Research.

U.S.-Czech Economic and Commercial Dialogue (ECD): The Department of Commerce maintains an Economic and Commercial Dialogue with the Czech Republic under which nuclear matters are discussed.

Regulatory Cooperation: The U.S. NRC and the National Nuclear Safety Administration of the People's Republic of China (NNSA) have an arrangement for the exchange of technical information and cooperation in nuclear safety and security matters. NNSA has also signed agreements with the NRC to join the Code Applications and Maintenance Program (CAMP) and the Cooperative Severe Accident Research Program (CSARP).

International Engagement

Figure 13: Additional Agreements	
Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	✓
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention on Third Party Liability in the Field of Nuclear Energy	
Vienna Convention on Civil Liability for Nuclear Damage	✓
Joint Protocol Relating to the Application of the Vienna Convention and Paris Convention	✓
Convention on Supplementary Compensation for Nuclear Damage	
Organization Membership	

IAEA	✓
Nuclear Suppliers Group	✓
OECD/NEA	✓
IFNEC	✓
GenIV International Forum (GIF)	✓
EURATOM	✓

Resources

For more information on the commercial opportunities in the Czech Republic, contact: Hana Obrusnikova (Commercial Specialist, Hana.Obrusnikova@trade.gov).

For more information on the civil nuclear industry in the Czech Republic, contact: MOIT website (<http://www.mpo.cz/>); ČEZ website (www.cez.cz); SÚJB website (www.sujb.cz)

Sources

CIA Factbook, United Nations, World Nuclear Association and U.S. Embassy Prague.

France

Market Type: Mature Existing Market

France is heavily dependent on nuclear energy and is a global supplier of nuclear technology, products and fuel cycle services. In recent years, France has announced its intent to diversify its energy mix by lowering nuclear energy generation from 75 percent to 50 percent of total electricity generation by 2025. Two majority state-owned companies – Areva and Électricité de France (EdF) dominate the industry – and, despite current financial challenges, their presence creates limited export opportunities for U.S. and foreign companies.

Overall
Rank

#12

Chargé d’Affaires at U.S. Embassy Paris: Uzra Zeya
Minister Counselor for Commercial Affairs in Paris: Steve Alley

Market Overview

France derives 75 percent of its electricity from its 58 nuclear power reactors and is the largest net exporter of electricity in the world. The plants are operated by state owned utility Électricité de France (EdF) and have a total capacity of 63.2GWe. Recent financial losses at France’s Areva led to an agreement whereby EdF will take a majority stake in the company’s nuclear reactor business (Areva NP), with Japan’s Mitsubishi Heavy Industries (MHI) proposing to take an equity stake of up to 34 percent in the whole company. The ongoing nature of this major industry restructuring makes it difficult to predict its impact on the French nuclear industry and its global presence.

Nuclear energy has been a critical part of France’s energy infrastructure since 1974 when the country decided to expand its nuclear capacity to ease the effects of oil shocks. This reliance on nuclear energy has resulted in very low emission levels, low costs to produce energy, and high energy production. Although France has one reactor under construction, Flamanville 3, the country is looking to lower the percentage of nuclear energy in its mix with a target of 50 percent of electricity supply by 2025.

France’s ongoing efforts to have state-controlled EdF (the world’s largest nuclear utility) acquire a majority stake in Areva NP, the newly created reactor and services side of Areva’s business, is a critical initiative that will impact the global competitiveness of the French nuclear industry. After Areva posted huge losses in 2014, in July 2015 EdF agreed to take on 51 percent of Areva NP; the contract was signed in November 2016 and will be concluded by the end of 2017, at which time this portion of the business will be reconstituted as New NP. New NP will hold all of Areva NP’s existing assets related to nuclear power, with the exception of assets and liabilities related to the completion of the Olkiluoto 3 EPR reactor in Finland, which will remain with Areva SA, along with some Le Creusot Forge potential liabilities (especially those related to forging anomalies of the reactor vessel at Flamanville 3). In May 2017, the European Commission (EC) approved this sale to EdF. As of May 2017, the equity in New Areva NP is set to be: 65 percent EDF, 15 percent Areva NewCo, 15 percent MHI, and 5 percent Assystem (a French engineering firm).

France is self-sufficient in its fuel cycle, with the exception of its uranium imports from Canada, Niger, Australia, Kazakhstan, and Russia. Areva operates in Canada and Niger, conducting exploration and mining of uranium. Areva is also active in the back-end fuel cycle. France has a closed fuel cycle, where used fuel is reprocessed to recover uranium and plutonium for reuse.

Public opinion in France regarding nuclear power is generally positive. A post-Fukushima survey showed 59 percent of respondents in favor of nuclear energy to ensure energy independence versus 54 percent before Fukushima. A 2016 poll by the French public opinion institute IFOP found that 53 percent of respondents were against a nuclear phase-out. The study found strong correlations between age and opinion on the use of nuclear energy, with younger people tending either to oppose nuclear or have no opinion, while their older peers were more supportive of nuclear.

Planned Nuclear Energy Projects

Flamanville 3 Nuclear Power Plant

Owner: Électricité de France

Reactor Type: European Pressurized Reactor

Capacity: 1,750 MW

Value of Project: 10.5 billion Euros

Construction Period: 2007-2018

Operation: EDF

Flamanville 3 NPP: The third reactor at the Flamanville site is also the largest and is the design for the reactor EDF is building at Hinkley Point C in the United Kingdom. Flamanville 3 was scheduled to take five years to build, but the deadline has been extended to 2020, and the cost is projected to be three times higher than the original 3.3 billion euro budget. In June 2017, the Nuclear Safety Authority (ASN) cleared the reactor for operation next year despite the findings of 2015 ASN investigation that revealed an excessive carbon concentration in reactor forgings. Nevertheless, the ASN has recommended that EDF install a new reactor cover by 2024.

Opportunities

France's nuclear industry is extremely self-sufficient and the country maintains a high level of energy independence. However, France is always seeking innovative products and technologies to update its operating fleet and plan for new reactor technologies.

Services (front-and back-end): Limited opportunities for decommissioning given that the average age of the French nuclear fleet is 30 years.

Legal and Consulting Services: Limited legal consulting services potential, but opportunities exist for lifetime extension and plans for new construction.

Licensing Support: No opportunities exist - the French Nuclear Safety Authority is the only state body that can issue, amend, modify, renew, suspend, and revoke licenses and permits for the safe conduct of the activities of a nuclear plant in France.

Design, Construction, and Operation: Opportunities may exist to support new construction of future EPR reactors, though France's self-sufficiency will limit major opportunities for U.S. companies. SMRs are an area of interest for France.

Components: Limited opportunities given France's robust nuclear manufacturing supply chain. One area of opportunity is digital instrumentation and control (I&C) systems to update analog instruments in France's existing reactors.

Challenges and Barriers

The major challenge for U.S. civil nuclear companies seeking to export to France is competition from state-owned EdF and Areva. France is self-sufficient in its nuclear program and does not rely significantly on foreign suppliers to operate its domestic fleet or support new build projects in third countries. An additional challenge is that French nuclear regulatory standards (IEC standards) can potentially create a bias against U.S. civil nuclear firms (adhering to ASME and IEEE standards) that want to enter the French market.

Energy Transition Law: adopted in August 2015, the French Energy Transition for Green Growth Law (Energy Transition Law) marks a turning point in France's carbon reporting and sets out a roadmap to mitigate climate change and diversify the country's energy mix. The law includes ambitious targets around reducing greenhouse gas (GHG) emissions and overall energy consumption, reducing the share of fossil fuels and nuclear power in favor of renewable energy, and increasing the price of carbon.

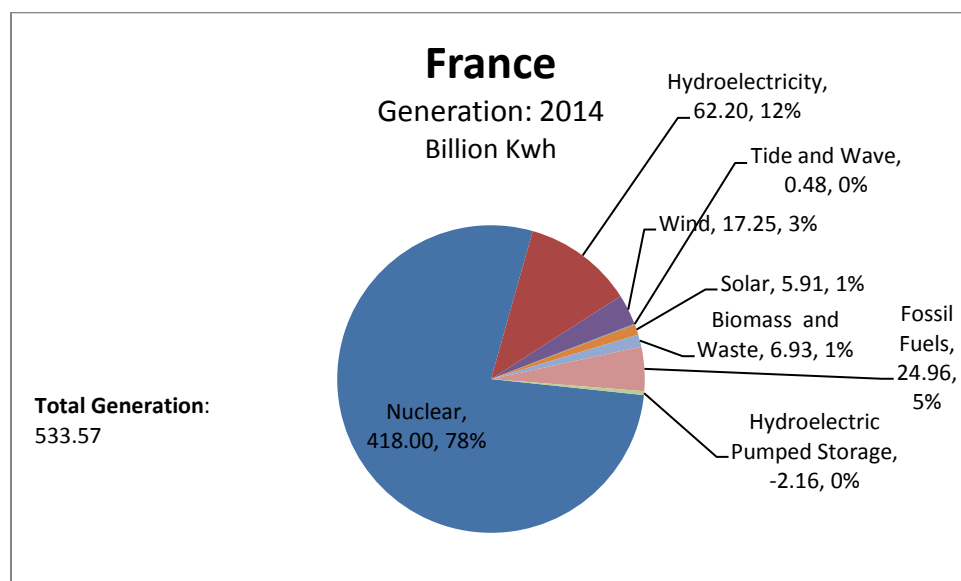
In 2016, the French government released its Multi-Annual Energy Program (or PPE) which determines priority government action areas for energy management to meet the Energy Transition Law objectives. Given the ambitious nature of the Energy Transition Law and the PPE, the timeframe for France to make its planned transition may take longer than initially stated.

Nuclear Infrastructure

Research reactors: France's CEA has 14 research reactors. The U.S. and Japan are cooperating with France in its development of sodium-cooled fast reactors through the Advanced Sodium Technological Reactor for Industrial Demonstration (Astrid) program.

Fuel: Few opportunities exist. France is self-sufficient in its nuclear fuel cycle, although it does import uranium oxide concentrate from Australia, Kazakhstan and Russia under long-term contracts, with the rest of the cycle done by Areva.

Waste Management: France disposes of its waste under the 1991 Waste Management Act, which established the National Radioactive Waste Management Agency (ANDRA). ANDRA has been researching a long-term storage solution and developing a report to enable government decision-making on France's waste policy. Currently, the Bure underground rock laboratory situated in clays has been developing experiments to simulate the heat the waste will generate and to observe its impact on the clay. ANDRA is set to file a construction license application for its deep geological repository project, the Industrial Center for Geological Disposal (CIGEO), by the end of 2017 and begin construction in 2020 with the goal of commencing pilot testing in 2025.



U.S. Government Collaboration

123 Agreement: Nuclear cooperation between the United States and France falls under the framework of the U.S.-EURATOM 123 Agreement, which expires in 2026 with rolling five-year extensions from thereafter.

Regulatory Cooperation: The U.S. NRC and the Autorite de Surete Nucleaire de France (ASN) and the Institut de Radioprotection et de Sûreté Nucléaire of France (IRSN) have an arrangement for the exchange of technical information and cooperation in nuclear safety and security matters. IRSN has also

signed agreements with the NRC to join the Code Applications and Maintenance Program (CAMP) and the Cooperative Severe Accident Research Program (CSARP).

International Engagement

France is a major player in the global nuclear sector. As the world's largest energy exporter, most of the electricity exported to Italy, the UK, Switzerland, and Belgium from France is produced by French NPPs. France is involved in nuclear construction projects in Finland (Olkiluoto 3), the UK (Hinkley Point C), China (Taishan 1&2), and Brazil (Angra 3). In addition, France has expressed interest pursuing future projects in Saudi Arabia, India, and Poland. The U.S. and Japan work with France under a trilateral memorandum of understanding (MOU) on the development of sodium-cooled fast reactors. In July 2012, Areva signed an agreement with Russia's Rosatom where both companies would cooperate in the provision of services to existing reactors as well as the management of nuclear waste and supply chains. In November 2015, Areva and the China National Nuclear Corporation (CNNC) signed an MOU for possible partnership on nuclear-waste recycling.

Figure 13: Additional Agreements	
Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	✓
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Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention on Third Party Liability in the Field of Nuclear Energy	
Vienna Convention on Civil Liability for Nuclear Damage	✓
Joint Protocol Relating to the Application of the Vienna Convention and Paris Convention	✓
Convention on Supplementary Compensation for Nuclear Damage	
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	✓
OECD/NEA	✓
IFNEC	✓
GenIV International Forum (GIF)	✓
EURATOM	✓

Resources

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For more information on the civil nuclear industry in France, contact:

SFEN – Société Française d’Energie Nucléaire – The French Nuclear Society (www.sfen.org)

ASN – Autorité de Sûreté Nucléaire- (www.French-nuclear-safety.fr)

AIFEN -The French nuclear industry association (www.aifen.fr/)

Sources

Revue Générale Nucléaire – French Nuclear Newsletter (www.revuegeneralenucleaire.fr), SFEN
CIA Factbook, United Nations, World Nuclear Association, and ITA contacts at the U.S. Embassy in Paris.

India

Market Type: Existing and Expanding

India has a large nuclear power program with substantial political support and aims to supply 25 percent of its energy from nuclear power by 2050. This expansion presents significant opportunities for U.S. industry, especially as the Indian government works to engage foreign firms in its plans. Nevertheless, ownership limitations and nuclear liability concerns remain serious barriers to U.S. civil nuclear exports.

Chargé d’Affaires to India: MaryKay Loss Carlson
U.S. Commerce Attaché to India: Patrick Santillo

Overall
Rank

#3

Market Overview

India has a rapidly growing nuclear power program, with 22 commercial nuclear power reactors, five under construction and 20 additional reactors planned. The Nuclear Power Corporation of India Ltd. (NPCIL), the state-owned operator of India’s reactor fleet, supplies 6.2 GWe of nuclear capacity, 3 percent of India’s 2014 electricity generation. India aims to increase nuclear generation to 25 percent of its energy mix by 2050. India’s current nuclear power market is estimated at \$150 billion and will grow further if its expansion plans are realized.

The Government of India (GOI) is supportive of nuclear power due to the country’s growing electricity demand and shortage of fossil fuels. Because India is not a signatory to the Nuclear Non-Proliferation Treaty (NPT), it was excluded from nuclear trade for 34 years, which limited its nuclear energy development to mostly indigenous designs. Since 2008, when the U.S. led a successful effort among Nuclear Supplier Group’s (NSG) Participating Governments to permit supply to India’s civil nuclear program, India has been working with other countries (primarily Russia, France and the United States) to supplement its indigenous PHWR program with foreign-supplied light-water reactors. NPCIL is responsible for design, construction, commissioning and operation of all India’s indigenous nuclear power plants but views international cooperation as an opportunity to expand its domestic program and eventually become an exporter of reactor technology.

To supplement its continued deployment of indigenous PHWRs, India plans to build nuclear parks comprising foreign-supplied advanced LWRs. Each park is to have 8 to 10 GWe of generation capacity – an impressive increase from the current capacity of any single site currently operating in India. U.S., French and Russian companies have been in talks and, in some cases, have reached deals to build nuclear reactors.

Before 2008, during the time when India’s nuclear market was cut off from nuclear trade, India’s nuclear power plants (NPPs) operated under capacity due to a shortage of uranium fuel. India’s limited uranium

reserves have led it to pursue a long-planned three-stage program to support a thorium fuel cycle, but the viability of realizing this objective remains uncertain.

For now, the 2008 U.S.-India nuclear deal has since removed restrictions against India, enabling India to import uranium and construct large foreign-built nuclear reactors. The agreement included a waiver to account for India not being a party to the NPT and lacked safeguards (two requirements under U.S. law). Currently, 40 percent of India's nuclear capacity operates under the IAEA safeguards and uses imported fuel.

Planned and Potential Nuclear Energy Projects

India is currently planning to build 20 reactors at nine sites. The next project to start construction will be the Kudankulam 3 and 4 plants in Tamil Nadu, comprising Russian-supplied VVERs, which are scheduled to begin construction in 2017 with operation to begin in 2022 to 2023. In total, India is planning to build 18,300 MWe of nuclear power.

In the 2008 U.S.-India nuclear deal, two prospective sites in Gujarat and Andhra Pradesh were designated as sites for U.S. reactor vendors Westinghouse (WEC) and GE-Hitachi (GEH). In December 2015, WEC and NPCIL announced expanded plans to build six reactors in India by 2030. Several U.S. civil nuclear companies have decided not to proceed with further investment in India, claiming that India's revised 2010 Civil Liability for Nuclear Damage Act does not provide adequate protection and is not in line with the CSC.

In June 2016, a White House Fact Sheet announced plans to finalize contractual negotiations between WEC and NPCIL by June 2017. However, delays in contract negotiations occurred in late 2016 and early 2017. Following WEC's chapter 11 bankruptcy protection filing, this timetable has slipped. Despite the bankruptcy proceedings, WEC and India have maintained their intentions to build the six WEC AP1000s reactors with construction of the facilities to be completed by a local partner and for WEC to take on a design- and consultancy-focused role. In a June 2017 Joint Statement, the leaders of both the U.S. and India reaffirmed their desire for WEC and NPCIL to conclude contractual agreements for the six AP1000 reactors. As of June 2017, both parties are still negotiating the parameters of this agreement.

In March 2016, NPCIL and France's EDF signed an MOU to construct six European Pressurized Reactors (EPR) of 1650 MWe each at Jaitapur in Maharashtra. Russia's Rosatom is currently constructing its VVER-1000 reactor at Kudankulam 2 and has announced plans to build twelve NPPs (VVER-1200 reactors) in India over the next 20 years.

All plants are owned and operated by NPCIL, except for a planned fast breeder reactor handled by the specialist fast breeder division Bhavini.

Opportunities

Services (front-and back-end): Moderate opportunities for feasibility studies and infrastructure development at India's planned NPPs.

Legal and Consulting Services: Moderate opportunities to advise NPCIL and DAE on new plant projects.

Licensing Support: Opportunities to support the Atomic Energy Regulatory Board (AERB), India's nuclear safety regulator.

Design, Construction, and Operation: Opportunities exist for new construction of 22 reactors, along with many others proposed. Foreign companies are only allowed minority stakes, however, as the 1962 Atomic Energy Act prohibits private control of nuclear power generation.

Components: Opportunities may exist for future plants.

Challenges and Barriers

While GOI support for nuclear energy is strong and the government wants foreign company involvement in the expansion of its nuclear program, there are several obstacles for U.S. civil nuclear exports. India's plan to build international nuclear parks is moving forward at a slower pace than anticipated. Additionally, India's 1962 Atomic Energy Act (AEA) prohibits private control of nuclear power generation. 2016 amendments to the AEA that allow for public (but not private) sector joint ventures and prohibit foreign direct investment in nuclear power (excluding the supply chain) may limit U.S. company involvement in India's nuclear projects.

Liability is another concern. India ratified the Convention on Supplementary Compensation for Nuclear Damage (CSC) in February 2016, and the U.S. government and the GOI have agreed that India's 2010 domestic Civil Liability for Nuclear Damage Act (CLND) is compatible with the CSC. Some U.S. suppliers, however, still have concerns about the interpretation of the CLND and its channeling of liability exclusively to the operator. To alleviate supplier concerns, India has created an insurance pool for nuclear operators in India and for foreign suppliers with a liability cap of 15 billion Indian Rupees (\$226 million).

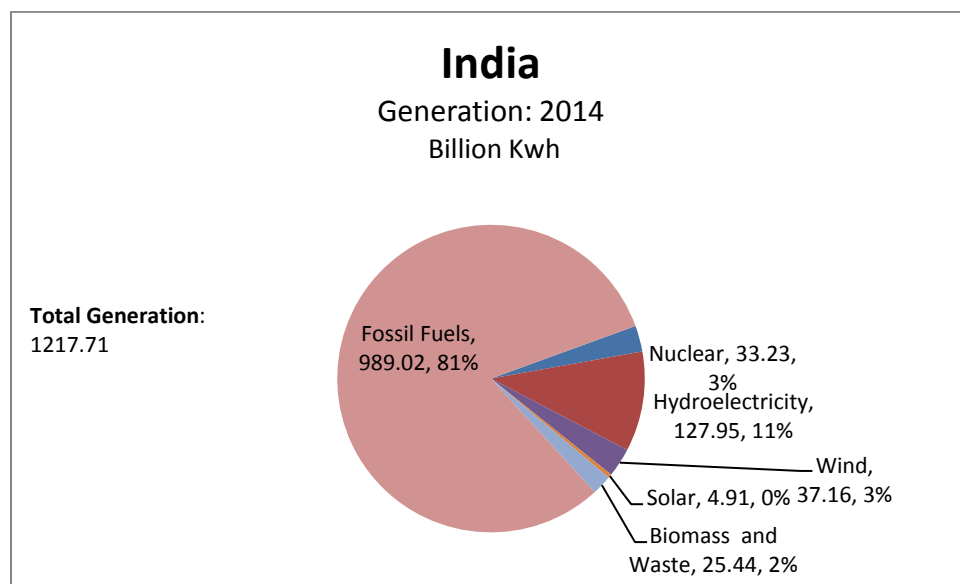
Nuclear Infrastructure

Research reactors: India has four research reactors. The Bhabha Atomic Research Center (BARC) operates two, while the Indira Gandhi Center for Atomic Research operates two others.

Fuel: Expertise exists in all areas of the nuclear fuel cycle, including exploration, mining, heavy water production, fabrication and reprocessing. India's long-term goal is to develop an advanced heavy-water

thorium cycle. India has some domestic uranium mining handled by the Uranium Corporation of India, Ltd (UCIL) but relies on 40 percent imported uranium to fuel its growing reactor fleet.

Waste Management: Waste is treated and stored at each NPP site. Waste immobilization plants are in operation. BARC is conducting research on final disposal of waste in a geological repository.



U.S. Government Collaboration

123 Agreement: The U.S.-India 123 Agreement entered into force in 2008. The agreement expires in December 2048 with rolling 10-year extensions.

U.S.-India High Technology Cooperation Group (HTCG): Established in 2002 to promote bilateral high technology commerce (specifically dual-use items) in partnership with the private sector. The HTCG is led by DOC's Bureau of Industry & Security (BIS).

U.S.-India Energy Dialogue: Launched in 2005 and led by the U.S. Department of Energy (DOE), this dialogue includes a Civil Nuclear Working Group that guides bilateral civil nuclear R&D efforts.

Global Center for Nuclear Energy Partnership: Established in 2010 by DOE's National Nuclear Security Administration (NNSA) and the GOI, the center focuses on bilateral nuclear security cooperation and other capabilities to secure vulnerable nuclear materials.

Regulatory Cooperation: The U.S. NRC and the Atomic Energy Regulatory Board of India (AERB) have an arrangement for the exchange of technical information and cooperation in nuclear safety and security matters.

Figure 15: Additional Agreements	
Non-Proliferation Treaty	
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention on Third Party Liability in the Field of Nuclear Energy	
Vienna Convention on Civil Liability for Nuclear Damage	
Joint Protocol Relating to the Application of the Vienna Convention and Paris Convention	
Convention on Supplementary Compensation for Nuclear Damage	✓
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	
OECD/NEA	
IFNEC	✓
GenIV International Forum (GIF)	
EURATOM	

Resources

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For more information on nuclear energy in India, see: India Department of Atomic Energy: <http://dae.nic.in/>

Atomic Energy Regulatory Board: <http://www.aerb.gov.in/>

Nuclear Power Corporation of India Ltd (NPCIL): <http://www.npcil.nic.in/>

Sources

CIA Factbook, United Nations, World Nuclear Association, Asian Development Bank, and our contacts at the U.S. Embassy in New Delhi and U.S. Consulates in India.

Japan

Market Type: Mature and Decommissioning

Japan's civil nuclear program has undergone tremendous changes since the March 2011 Fukushima Daiichi accident. Of Japan's 42 operable reactors, 5 are currently in operation with another 19 having applied to restart; the government is working to find a politically acceptable plan for restarting as many reactors as possible, with a goal of approximately 30 operating reactors by 2030. Viable opportunities for U.S. exports exist for decontamination and remediation services at Fukushima, decommissioning, as well as other goods/services for Japan's existing reactor fleet.

Overall
Rank

#5

Chargé d'Affaires to Japan: Jason P. Hyland
U.S. Commerce Attaché to Japan: Keith Kirkham

Market Overview

Japan has 42 operational reactors, according to the IAEA Power Reactor Information System (PRIS) database, making up a net capacity of 42.6 GWe. However, following the March 2011 Fukushima accident, all reactors were taken offline as Japan revised its nuclear safety regulations. Subtracting out the six reactors on the Fukushima Daiichi site, Japan has 42 reactors potentially available for restart. The Government of Japan (GOJ) has a goal of reaching 20-22 percent nuclear by 2030, which would require 30 operating reactors.

Additionally, in December 2016, the major Japanese company Toshiba announced financial losses related to its acquisition of U.S. reactor designer Westinghouse. These losses, combined with an accounting scandal from 2015, have resulted in significant financial challenges for Toshiba. Toshiba and Westinghouse are undergoing ongoing restructuring to maintain their viability.

Loss of nuclear power has caused hardship to Japan's trade balance, energy security and economy. To make up for the loss of nuclear generated electricity, Japan was forced to boost imports of oil and gas, and its dependency on fossil fuels rose from 60 percent before the earthquake to 90 percent afterward. As a result, in 2011, Japan had a trade deficit for the first time in over 30 years, and the deficit has increased each year since then. Recent estimates have placed Fukushima related losses for the Japanese nuclear industry at \$50 billion.

Given these challenges, the GOJ has prioritized restarting part of its nuclear reactor fleet. The government's fourth Strategic Energy Plan, released in April 2014, recognized the role that nuclear energy must play in a diversified, secure and efficient energy supply. Though it did not specify targets for nuclear energy or renewables, it explicitly stated the government's intention to focus on restarting reactors in the near-term while also noting the need to reduce dependence on nuclear energy from pre-

Fukushima levels. Several plants have applied for restart but are currently facing legal and public opinion challenges. As of June 2017, five reactors are currently in operation, including: Kyushu Electric Power's (KEP) Sendai 1 and 2, Shikoku Electric's Ikata 3, and most recently Kansai Electric Power's Takahama 3 and 4. Another 19 reactors have applied to restart pending review by the Nuclear Regulation Authority (NRA) and local government, with a Japanese court granting approval for the restart of two reactors at KEPCO's Genkai plant, despite opposition from residents.

Aside from reactor restarts, the GOJ's main focus has been the cleanup and policy response to the Fukushima accident. The International Research Institute for Nuclear Decommissioning (IRID) was established in August 2013 to research and develop technologies to assist with nuclear decommissioning, promote cooperation with international and domestic organizations on nuclear decommissioning and develop human resources for R&D. Over the past year, the GOJ has increasingly sought international assistance to address contaminated water issues at the Fukushima Daiichi Nuclear Power Station and advice on decommissioning and decontamination projects.

Japan is building several fuel cycle facilities in an attempt to achieve commercial-scale capabilities in all aspects of the fuel cycle. Current construction projects include a MOX fuel fabrication plant at the Rokkasho site. After years of delay, Japan recently completed construction of the Rokkasho commercial-scale reprocessing facility, although it has yet to begin commercial operation, which was once again delayed until 2018. Japan has converted several reactors to be MOX fuel bearing and plans to convert others. The government has operated a prototype fast reactor, Monju, though it was recently placed in long-term shutdown, and the GOJ confirmed in December 2016 it would begin its decommissioning. The GOJ has another fast test reactor called Joyo and intends to continue developing its fast reactor capabilities through both domestic facilities and international cooperation.

Opportunities

Services (front-and back-end): Advisory services for decommissioning and decontamination and assistance with safety upgrades to reactor fleet. Japan plans to decommission many of its older NPPs and is seeking international expertise in this area. U.S. companies' extensive decommissioning experience makes them well-placed to assist Japan with its decommissioning needs.

Legal and Consulting Services: Advisory assistance with Fukushima cleanup and public relations in line with NRA guidelines.

Design, Construction, and Operation: Limited due to post-Fukushima halt of new nuclear construction.

Licensing Support: Potential for advisory assistance to electric utilities.

Fuel Management: Limited potential.

Waste Management: Limited potential.

Challenges and Barriers

Reduced market access, government policy and public opinion are significant challenges to U.S. civil nuclear exports to Japan. In its response to the Fukushima accident, Japan has shown a limited inclination to seek help from industry abroad, preferring to keep tight control on managing contaminated water leaks and other challenges related to the decontamination and decommissioning of the site. Recently, Japan has made more of an effort to seek international assistance, which could result in more opportunities for U.S. industry involvement.

The restart of Japanese reactors could produce export opportunities for U.S. goods and services, particularly as Japanese reactors undergo safety improvements and the nation continues to adapt to its post-Fukushima regulatory and safety policies. While the current government is in favor of reactor restarts, opposition from the Japanese public, often acting in tandem with the courts, has caused significant delays, and it is unclear how successful the government's restart policy will be. Even if Japan overcomes these hurdles to revitalizing its civil nuclear program, U.S. content for civil nuclear projects in Japan will be limited due to the strength, experience and capability of Japan's industry. U.S. industry also faces strong competition from other countries, such as France and Russia, for other areas of the fuel cycle, such as fast reactors, MOX facilities and reprocessing technology.

Despite the above challenges, the U.S. and Japanese civil nuclear industries remain highly integrated and have years of experience collaborating on projects. Japan is and will remain an important partner for the United States in the civil nuclear sector. USG support for U.S. civil nuclear exports is essential, particularly as Japan continues to pursue its post-Fukushima priorities.

Nuclear Infrastructure

Research Reactor: The Japan Atomic Energy Agency (JAEA) manages an extensive R&D program throughout the country and runs several research reactors, including the fast test reactor Joyo and the High Temperature Test Reactor, and other experimental test facilities.

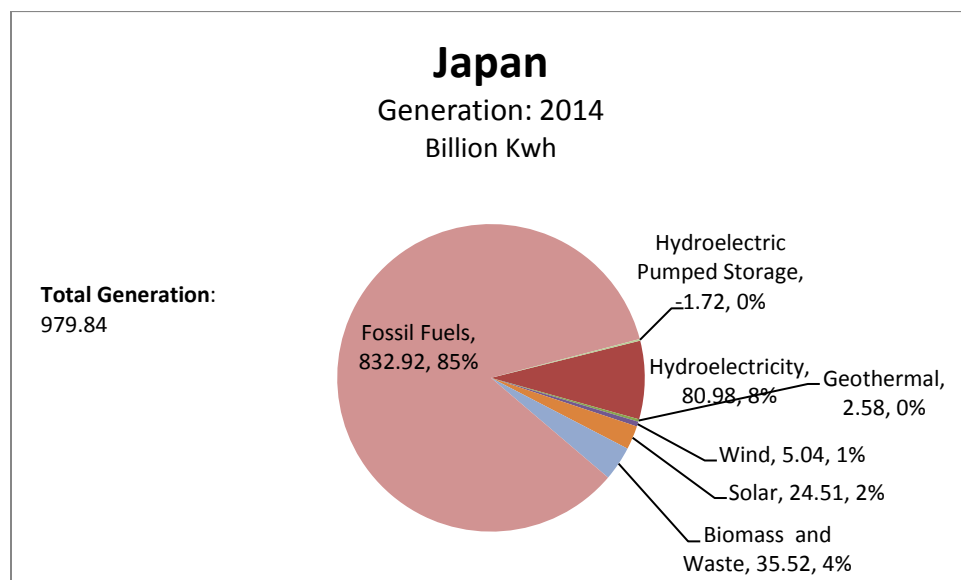
Fuel: Japan has no indigenous uranium. Uranium imports come primarily from Australia, Canada and Kazakhstan; Japanese companies are increasingly taking equity in overseas uranium projects, including in Uzbekistan, Kazakhstan, Australia and Namibia.

Fuel Cycle: Japan has fuel cycle facilities, though not yet at commercial scale. Japan Nuclear Fuel Ltd (JNFL) operates a commercial enrichment plant at Rokkasho, though much enrichment is still imported. A new enrichment plant in Japan using Russian centrifuge technology is planned under an agreement between Rosatom and Toshiba.

Several fuel fabrication facilities exist to supply Japan's fleet of PWRs, BWRs and, in a limited capacity, HTRs, as well as a MOX fuel-bearing reactor for R&D purposes. A new 600 tU/yr plant is planned by Areva and Mitsubishi Nuclear Fuel (MNF). JNFL is building a MOX fuel fabrication plant in Rokkasho, known as J-MOX, though due to construction delays most MOX is fabricated in France using Japanese fuel.

A commercial scale reprocessing facility at Rokkasho has recently finished construction but is awaiting the start of commercial operation having been further delayed until 2018. The Japan Atomic Energy Agency (JAEA) recently announced that it will permanently shut down the Tokai pilot reprocessing plant, which has stood idle since 2006.

Waste Management: Japan's first high-level waste (HLW) interim storage facility opened in Rokkashomura in 1995. A permanent HLW storage facility is part of the 2014 energy strategy. Facility siting is a major challenge.



U.S. Government Collaboration

123 Agreement: Japan's 123 Agreement with the United States has an initial term of 30 years through July 30, 2018, but will remain in force until terminated by either party.

U.S.-Japan Fukushima Recovery Forum: In February 2015, the U.S. and Japan organized the third Fukushima Recovery Forum in Tokyo to identify bilateral activities for the U.S. to assist Japan in its decommissioning, decontamination, and remediation efforts.

U.S.-Japan Bilateral Commission on Civil Nuclear Energy Cooperation (BLC): Established in April 2012, the BLC serves as a forum to foster a strategic dialogue and joint activities related to the safe and secure use of civil nuclear energy and the response to Fukushima. The BLC includes five working groups: (1) Nuclear security, (2) Civil nuclear energy research and development, (3) Safety and regulatory issues, (4) Emergency management, and (5) Decommissioning and environmental management.

Regulatory Cooperation: The U.S. NRC and the Nuclear Regulation Authority of Japan (NRA) have an arrangement for the exchange of technical information and cooperation in nuclear safety and security matters. NRA has also signed agreements with the NRC to join the Code Applications and Maintenance Program (CAMP) and the Cooperative Severe Accident Research Program (CSARP).

International Engagement

Japanese government officials have been actively marketing Japanese reactors around the world during diplomatic visits, particularly in regions such as Southeast Asia, Africa and the Middle East.

Japan's civil nuclear industry has extensive ties to U.S. and French industry. Toshiba owns 87 percent of Westinghouse Electric Company; Hitachi and GE have a joint venture partnership; and MHI partners with Areva.

Japan engages with many countries on advanced civil nuclear R&D in all parts of the fuel cycle, including laboratory-to-laboratory R&D as well as planning and constructing test and demonstration facilities.

Figure 9: Additional Agreements	
Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	✓
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention on Third Party Liability in the Field of Nuclear Energy	
Vienna Convention on Civil Liability for Nuclear Damage	
Joint Protocol Relating to the Application of the Vienna Convention and Paris Convention	
Convention on Supplementary Compensation for Nuclear Damage	✓
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	✓
OECD/NEA	✓
IFNEC	✓
GenIV International Forum (GIF)	✓
EURATOM	

Resources

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For more information on the civil nuclear industry in Japan, see:

U.S. Commercial Service Japan - Market Alerts on nuclear remediation and decommissioning opportunities in Japan: <http://www.export.gov/japan/fukushima/index.asp>

JAEA: <http://www.jaea.go.jp/>

NRA: <http://www.nsr.go.jp/>

IRID: <http://irid.or.jp/en/>

Sources

CIA Factbook, United Nations, World Nuclear Association, Asian Development Bank, and ITA contacts at the U.S. Embassy in Tokyo and U.S. Consulate in Osaka.

Republic of Korea

Market Type: Mature and Decommissioning

The Republic of Korea (ROK) has indigenized its nuclear power industry to the extent that new builds no longer rely heavily on U.S. content. The ROK has emerged as a leading competitor after it won a bid for the Barakah plant in the United Arab Emirates. Despite domestic self-sufficiency, a long history of cooperation with U.S. industry ensures future export opportunities. Korea's new President, Moon Jae-in, who took office in May 2017, has pledged to reduce the country's reliance on nuclear power but it's unclear to what extent the ROK will implement these plans given its reliance on nuclear power and export ambitions for its APR-1400 reactor.

Overall
Rank

#13

Chargé d'Affaires ad interim U.S. Embassy, Seoul: Marc Knapper
U.S. Commerce Attaché to U.S. Embassy, Seoul: Daniel Lew

Market Overview

The Republic of Korea (ROK) currently has 25 operational reactors with a net capacity of 23.12 GWe which provide approximately 30 percent of the ROK's electricity. Three reactors consisting of an additional 4.20 GWe are under construction. Korea's reactors are located at four sites and all new builds are expected to be at these sites. The country's new President, Moon Jae-in, wants to reduce the country's reliance on coal to mitigate air pollution, citing concerns about safety, work towards a long-term phase-out of nuclear power.

As of June 2017, it was unclear to what extent the new ROK government will follow through on its nuclear power reduction plans given the ROK's reliance on nuclear power and export ambitions for its APR-1400 reactor. President Moon's campaign pledges on nuclear power include: scraping plans to build new reactors, banning life extension of old reactors, suspending construction of Shin Kori 5 & 6, re-examining policies on spent nuclear fuel and waste, and cutting utility prices in areas with nuclear power plants (NPPs). Moon's plans to halt construction of Shin Kori 5 & 6 (30 percent complete as of June 2017) have led to protests from residents, academics and politicians, who state that Moon's policy would jeopardize the country's nuclear industry and lead to electricity price rises.

From Korea's first reactor, which achieved commercial operation in 1978 to the late 1990s, Korea's reactor fleet consisted of a variety of foreign designs: six Westinghouse PWRs, four Candu PHWRs, two Framatome (now Areva) PWRs and two Combustion Energy (C-E, now owned by Westinghouse) PWRs. In 1987, Korea began a 10-year technology transfer plan with C-E. The resulting design, the OPR-1000, was largely based on C-E's System 80 model and became the sole design for Korea's subsequent new builds. Ten OPR-1000s have become operational since 1998, with the latest entering operation in July 2015.

The Generation-III APR-1400, based on the C-E System 80+ model, is the successor to the OPR-1000. Three APR-1400s are under construction in Korea. The first APR-1400 entered commercial operation in December 2016. Korea is marketing the APR-1400 for export, citing its superior safety features, low generation cost per kilowatt-hour and short construction time, which, according to the Korea Electric Power Company (KEPCO), has been reduced to 41 months. Four APR-1400s are currently being built in UAE at Barakah, with the reactors entering service between 2017 and 2020.

A series of corruption scandals in 2012 and 2013 regarding falsified quality assurance certificates for reactor components caused South Korea to pledge a review of all reactors and a probe into the state-run Korea Hydro & Nuclear Power Co. (KHNP). A total of five reactors were taken offline temporarily, and three that were under construction were delayed while parts that failed testing were replaced. In January 2014, the Korean Ministry of Trade, Industry and Energy (MOTIE) finalized its second National Basic Energy Plan, which indicated that the country's target for installed nuclear capacity would compose 29 percent of its energy mix by 2035, down from the previous goal of 41 percent by 2030. This still represents a marked increase in its current nuclear power generation capacity.

The Korea Atomic Energy Research Institute (KAERI) is developing a 100 MWe SMR, called SMART (System-integrated Modular Advanced Reactor), that it intends to market for export. It has entered discussions with Saudi Arabia to build a SMART reactor in cooperation with KA-CARE. A U.S. engineering firm provided technical services to KAERI during SMR development.

Planned Nuclear Energy Projects

Construction of nine new reactors has begun or is planned over the next twelve years. According to the IAEA PRIS Database, the ROK has three reactors under construction, Shin Kori 4 and Shin Hanul 1&2 (all APR-1400s). As of May 2017, KHNP notes that Shin Kori 4 is 99.5 percent complete and Shin Hanul 1&2 are 94.5 percent complete. Shin Kori 5&6 are in the pre-construction phase. Four units are planned for construction, Shin Hanul 3&4 (APR-1400s) and Cheonji 1&2 (APR Plus).

Opportunities

Design, Construction, and Operation: Mostly concentrated with local companies. In June 2017, a final decision was made to decommission KHNP's Kori-1 reactor, which could lead to opportunities for U.S. companies. There are also opportunities for U.S. companies to cooperate with the ROK on future exports of the APR-1400 to third countries.

Components: Mostly concentrated with local companies.

Challenges and Barriers

The ROK's policy of technology transfer and indigenization has greatly reduced market access for U.S. industry, particularly for new builds. Korea was once a premier destination for U.S. civil nuclear exports, as U.S. reactor vendors joined those of France and Canada to supply Korea with 14 of its first 15 reactors. Korea now exclusively relies on indigenous designs for its new reactor builds, and the amount of local content on these reactors has become high. Recently, Korea's growing capabilities and export ambitions have turned it into a direct competitor with U.S. industry for exports to third countries, most noticeably to the UAE, where a Korean consortium won the Barakah tender over competing bids from GE-Hitachi and Areva.

Despite Korea's self-sufficiency, U.S. industry has strong ties to the Korean civil nuclear market, and there are still ample opportunities for exports of goods and services. Westinghouse, for example, is supplying up to \$2 billion in components and technical support for the UAE's Barakah nuclear power plant. Westinghouse is also involved in a joint venture with KNFC to make control element assemblies for combustion engineering-designed power reactors in the ROK.

Government support for the country's nuclear program is strong, but the May 2017 change in administration has created uncertainty for the ROK's future nuclear plans. The ROK government plans to conduct an in-depth review of the safety of nuclear power before new policies are put in place. The country remains committed to exporting its APR-1400 and scaling down domestic nuclear capacity could hurt its ability to achieve its export goals. Korea scores highly on all financial indicators. Liability, however, continues to be an issue. Despite efforts by U.S. government and industry, Korea has not yet agreed to join the CSC.

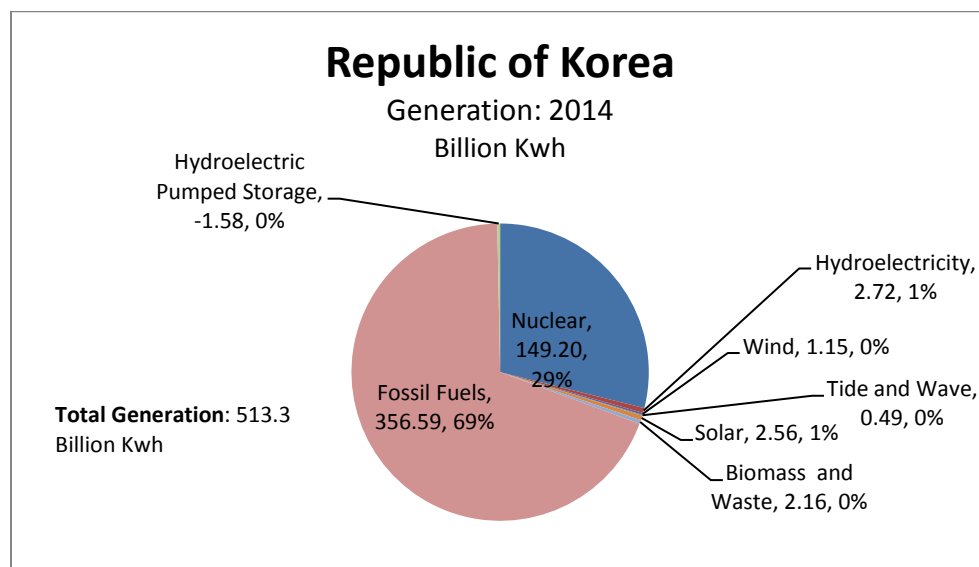
Public support of new nuclear energy projects is low despite the number of new projects. According to the most recent public survey by the Korea Nuclear Energy Agency (KNEA), through which more than 1,000 residents were interviewed, only 18.9 percent supported new builds in their vicinity. Conversely, 78.6 percent of those surveyed said there was a need for nuclear energy in the country.

Nuclear Infrastructure

Research Reactor: KAERI has a 30 MWt research reactor that started operation in 1995. It is the basis for the research reactor it is exporting to Jordan. An additional 20 MWe reactor and radioisotope facility in Busan is planned to be operational in 2017.

Fuel: Fuel for Korea's reactors comes from overseas, including Kazakhstan and Canada. Korea has a small quantity of uranium deposits, and mining at the Daejin site is planned for the near future. Some Korean officials have addressed the possibilities of removing fuel enrichment constraints as established in the U.S.–ROK 123 Agreement, as well as the possibility of the establishment of a Korean enrichment plant under international control, but no official developments have emerged from this yet.

Waste Management: Low and intermediate-level wastes are stored at each reactor site. A central disposal repository is being built at Gyeongju. The Korea Radioactive Waste Management Co. Ltd (KRWM) was set up early in 2009 as an umbrella organization to resolve South Korea’s waste management issues and waste disposition and, in particular, to create a national consensus on high-level wastes. In 2016, the U.S – ROK High Level Bilateral Commission held its first meeting, which saw the creation of four working groups for collaboration on the management of used fuel, the promotion of nuclear exports and export control cooperation, assured fuel supply, and nuclear security.



U.S. Government Collaboration

123 Agreement: The United States and the ROK signed a new 123 Agreement on June 16, 2015, and it entered into force on November 25, 2015. The new agreement has a 20-year term, with option for a 5-year extension.

U.S.-ROK High-Level Bilateral Commission (HLBC): Established in March 2016 under the U.S.-ROK 123 Agreement as a forum coordinate cooperation on assured fuel supply, spent fuel management, nuclear security, joint export promotion, and nuclear export controls.

U.S.-ROK Joint Standing Committee on Nuclear Energy Cooperation (JSCNEC): A cooperative initiative in the areas of nuclear energy, nonproliferation, nuclear safety, safeguards, export controls and nuclear security, and emergency preparedness.

Regulatory Cooperation: The U.S. NRC and the Nuclear Safety and Security Commission of the ROK (NSSC) have an arrangement for the exchange of technical information and cooperation in nuclear

safety and security matters. NSSC, via the Korea Institute for Nuclear Safety (KINS) has also signed agreements with the NRC to join the Code Applications and Maintenance Program (CAMP) and the Cooperative Severe Accident Research Program (CSARP).

International Engagement

In December 2009, the ROK won a bid to build four nuclear reactors in the United Arab Emirates worth \$20 billion. It is actively seeking other export opportunities for its APR1400 design and SMART SMR design. Korea is highly engaged with other countries for R&D, training and resource development. In 2011, it signed agreements with India and Saudi Arabia for nuclear energy cooperation covering joint work on R&D, design, construction, operation, maintenance and development of NPPs. The ROK is also exploring export opportunities in Egypt, Kenya, the Philippines, Vietnam, and the Czech Republic, including two recently signed agreements, one with Kenya to cooperate on the construction of NPPs, and one in Ukraine to help complete the construction of two reactors.

Additional Agreements	
Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	✓
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention Liability Agreement	
Vienna Convention Liability Agreement	
Joint Protocol Liability Agreement	
Convention on Supplementary Compensation for Nuclear Damage	
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	✓
OECD/NEA	✓
IFNEC	✓
GIF	✓
EURATOM	

Resources

For more information on the commercial opportunities in the Republic of Korea, contact: Commercial Officer Daniel Lew (daniel.lew@trade.gov); SB Shin (Commercial Specialist in Seoul, sb.shin@trade.gov).

For more information on nuclear energy in the ROK: KEPCO website
<http://home.kepco.co.kr/kepco/EN/main.do>

Sources

CIA Factbook, United Nations, World Nuclear Association, Asian Development Bank, KHNP, and ITA contacts at the U.S. Embassy in Seoul and the Korea Nuclear Energy Agency.

Malaysia

Market Type: Newly Emerging

Malaysia is interested in developing a civil nuclear industry to diversify its energy sources and address rising energy demand. The IAEA's March 2017 review of Malaysia's infrastructure development could lead to the development of a national nuclear framework. While the country currently lacks a liability regime and does not have a 123 Agreement with the United States, a more firm commitment by the Malaysian government could position the country as a growing market for U.S. civil nuclear exports.

Overall
Rank

#30

U.S. Ambassador to Malaysia: Kamala Shirin Lakhdhir
U.S. Commerce Attaché to Malaysia: Catherine Spillman

Market Overview

Currently, Malaysia does not have any operational nuclear power plants (NPPs), and it is not building any.

The Malaysian government established a nuclear agency, Agensi Nuklear Malaysia (ANM), charged with the research and development for new nuclear power and policy. ANM collaborates with the Malaysia Nuclear Power Corporation (MNPC) to lead the development of Malaysia's nuclear project planning. ANM has stated its intention to strongly consider nuclear energy as an alternative to coal. However, plans for an NPP have been delayed several times and are still in an exploratory stage. Preliminary plans have been made to establish the country's first two NPPs, but construction has been delayed until after 2030.

In late 2013 Malaysian officials announced plans to slow Malaysia's move to nuclear power. The Minister of Energy indicated during the World Energy Congress that widespread support did not yet exist for nuclear power, particularly after the events of Fukushima, and that current plans would be "kept in view" until further notice. However, in March 2017, the IAEA completed an Integrated Nuclear Infrastructure Review (INIR) mission, a three-phase assessment of Malaysia's nuclear infrastructure potential, determining that Malaysia is prepared to begin making decisive action in nuclear energy planning. The IAEA recommended that Malaysia develop plans for an own-operate plant. In addition, the CEO of MNPC has stressed the country's current focus on crafting a domestic legal framework for nuclear power.

In 2015, the MNPC noted that it had signed non-disclosure agreements with nine potential partners, including Westinghouse and China National Nuclear Corporation (CNCC) to obtain information to access nuclear technology. In addition to cooperating with the Indonesian Regulatory Authority and the Korea

Nuclear Safety and Security Commission, Malaysia has also entered into negotiations for cooperation on nuclear security with Mauritania and Sudan, through the guidance of the IAEA.

Planned Nuclear Energy Projects

Owner: Government of Malaysia

Operator: Malaysia Nuclear Power Group

Reactor Type: Enriched Uranium (possible)

Capacity: N/A

Value of Project: 42.3 billion (2010 est.)

Construction Period: 10 years, unlikely to start before 2030

Operation: TBD

Opportunities

Services (front-and back-end): Few immediate opportunities; possibilities for legal and regulatory infrastructure development, given the IAEA's determinations from its recent INIR mission

Licensing Support: Potential support for Malaysia's Atomic Energy Licensing Board

Design, Construction and Operations: New reactors are under consideration

Components: Study phase

Fuel Management: Study phase

Waste Management: Study phase

Challenges and Barriers

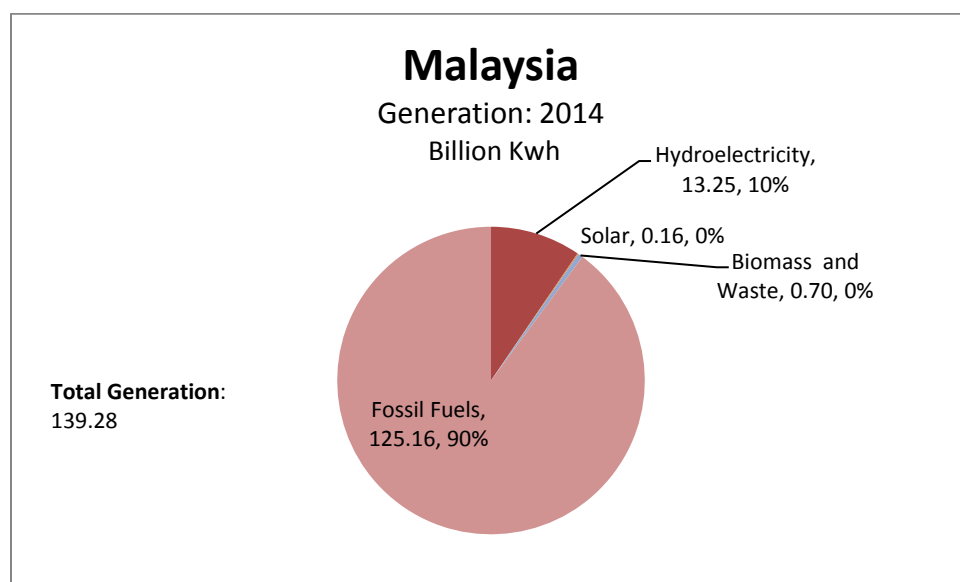
The lack of a national decision to build new nuclear power plants is the chief obstacle to U.S. civil nuclear exports. Despite some statements in the late 2000s in support of nuclear power and the recent IAEA INIR mission study, the Malaysian nuclear program has not progressed beyond exploratory stages. More recent policy statements and news are encouraging; however, the country's cautionary and long-term approach will delay groundbreaking for years to come.

If government support increased and solid plans took shape, Malaysia would be positioned as a key potential market for U.S. exports. The lack of a liability regime and a 123 Agreement are current barriers, but Malaysia is better placed to overcome financial and legal obstacles than other emerging nuclear energy countries.

Nuclear Infrastructure

Research Reactor: The 1 MW reactor TRIGA PUSPATI (RTP), which started operation in 1982, is the only nuclear research reactor in Malaysia. It is managed by the Malaysian Nuclear Agency (Nuklear Malaysia).

Waste Management: The Waste Technology Development Centre (WasTeC-Nuclear Malaysia) has been given the responsibility of managing radioactive waste throughout the nation.



U.S. Government Collaboration

123 Agreement: Malaysia does not have a 123 Agreement with the United States.

Additional Agreements	
Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	
Joint Convention on Safety of Spent Fuel Management	
Convention on Nuclear Safety	
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention Liability Agreement	

Vienna Convention Liability Agreement	
Joint Protocol Liability Agreement	
Convention on Supplementary Compensation for Nuclear Damage	
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	
OECD/NEA	
IFNEC	✓
GIF	
EURATOM	

Resources

For more information on the commercial opportunities in Malaysia, contact: CS Kuala Lumpur: Commercial Specialist Randall Liew (randall.liew@trade.gov)

For more information on Malaysia's Energy and Electricity Statistics, see:

Malaysia Energy Statistics Handbook 2016 - <http://www.st.gov.my/index.php/en/download-page/category/116-statistics-energy?download=626:malaysia-energy-statistics-handbook-2016>

Performance and Statistical Information on Electricity Supply Industry in Malaysia 2014 - <http://st.gov.my/index.php/industry/statistics-reports.html?download=588:performance-and-statistical-information-on-electricity-supply-industry-in-malaysia-2014>

Sources

CIA Factbook, International Atomic Energy Agency, Nuclear Security Summit, United Nations, World Nuclear Association, Asian Development Bank, and ITA contacts at Post.

Mexico

Market Type: Existing and Expanding

Mexico maintains two operational GE-designed BWR reactors at Laguna Verde. The Mexican government is interested in constructing new nuclear reactors as well as an expansion of the Laguna Verde plant. If these plans move forward, U.S. civil nuclear companies will be in a strong export position due to Mexico's close proximity and long-standing ties with Mexico's nuclear industry. American companies also remain uniquely primed to supply goods and services for the existing Laguna Verde reactors. However, recent low gas prices have the potential to delay action on investment in nuclear projects.

Overall
Rank

#6

U.S. Ambassador to Mexico: Roberta Jacobson

Market Overview

Mexico currently has two operational, GE-designed, Boiling Water Reactors (BWR) at Laguna Verde. The two plants supply about 3 percent of the nation's electricity. For several years, the Government of Mexico (GOM) has considered building new nuclear power plants (NPPs), beginning with two additional units at Laguna Verde. Mexico has also considered utilizing small modular reactors (SMRs) for power generation and seawater desalination. Mexico's Federal Electricity Commission (CFE) plans to add 4,080 MWe of nuclear power in the 2028-2030 period, increasing nuclear energy generation from 3 percent to 7 percent in Mexico's energy mix.

In May 2016, Mexico's National Electric System Development Program listed plans to acquire three new NPPs, with commercial operation slated for 2028, 2029, and 2030. Despite being a net energy exporter, Mexico wants to develop nuclear energy to reduce its carbon emissions and its dependence on hydrocarbons. Low gas prices have buoyed this reliance, and the CFE has invested in new gas-fired plants and is planning on expanding natural gas fired power generation, which will make up the majority of Mexico's energy mix. These CFE fossil fuel projects and low natural gas prices could delay Mexico's nuclear energy plans.

Between 2007 and 2013, the CFE, which owns the Laguna Verde plant, contracted with Spain's Iberdrola Engineering and France's Alstom to replace components and uprate both reactors, resulting in a 20 percent increase in net power capacity to 2,317 MWe. Operating licenses for Laguna Verde Units 1 and 2 expire June 2020 and April 2025, respectively; CFE is working to request license extensions, but no formal application has been filed to date. Additionally, the Mexican Nuclear Energy Law is under revision and is expected to be approved by Mexican Congress sometime in 2017. Mexican officials have noted that the revised law will align with the principles of the CSC.

Mexico's Energy Transition Law (passed December 2015), the last major remaining legislative piece of Mexico's comprehensive energy reform, codifies the framework for the country's transition to a cleaner energy matrix, including nuclear energy, with interim targets and formalization of a clean energy certificate program. The reform also transforms CFE into a "state productive enterprise" that will sell electricity to the national grid, which could accelerate Laguna Verde expansion plans. Mexico aims to generate 35 percent of its electricity from clean energy by 2024 and 50 percent by 2050.

Planned Nuclear Energy Projects

Additional Laguna Verde Reactors

Owner: Mexico's Federal Electricity Commission (CFE)

Reactor Type: BWR

Capacity: 1,400 MWe (2 units)

Value of Project: \$11 billion (estimated)

Construction Period: TBD

Operation (tentative): 2028 and 2030

Comment: An international tender could be released soon. Competitors for the project include the United States, Russia, France, Japan, South Korea and China.

Opportunities

Services (front-and back-end): Possibilities for feasibility and site characterization studies, emergency management planning, and infrastructure development for the Laguna Verde reactor expansion.

Licensing Support: Limited opportunities on the immediate horizon.

Design, Construction, and Operation: Opportunities will be available once new reactors are under consideration.

Components: Potential with new reactor builds. Some opportunities to provide equipment, design and engineering services to existing reactors

Fuel Management: Limited opportunities.

Waste Management: Potential services for future disposal site.

Challenges and Barriers

Mexico's potential expansion of the Laguna Verde NPP presents a great opportunity for U.S. industry. Beyond this project, however, the overall prospect for U.S. civil nuclear exports remains limited. Since 2010, Mexico has made several revisions to its nuclear power development plans. Mexico scaled back its

nuclear development plans in response to the March 2011 Fukushima accident. In 2015, Mexico tentatively committed to building three additional reactors, a reduction from the 6-8 new reactors announced in 2010. Local content requirements for future projects could also impact the feasibility of increased U.S. exports in this sector. The outcome of Mexico's July 2018 Presidential election could also impact the country's nuclear energy plans.

Financing will be a key challenge, as it is for most countries seeking to build new NPPs. Mexico's strong relationship with the U.S. nuclear industry and experience with U.S. EXIM Bank through the Laguna Verde NPP should help to mitigate this challenge.

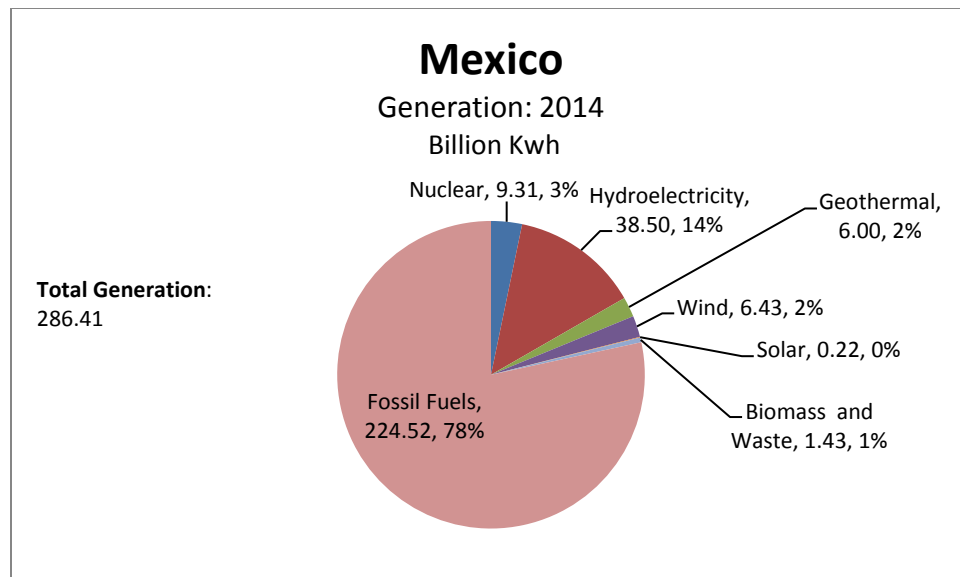
Nuclear Infrastructure

Research Reactor: Mexico operates three research reactors. The National Nuclear Research Institute (ININ) operates a 1 MWe Triga Mk III that has been operational since 1968; the University Autonoma de Zacatecas has had a subcritical Chicago Modelo 900 assembly used for training since 1969; there is a Chicago Modelo 2000 at the Instituto Politécnico Nacional (National Polytechnic Institute).

Fuel: Mexico's Secretariat of Energy (SENER) delegates to the Mineral Resources Board the responsibility for uranium mining and prospecting policy. Two-thousand tons of uranium reserves have been identified in Mexico but have been too expensive to exploit at current prices.

Waste Management: The SOE is responsible for used fuel storage and disposal. A collection, treatment and storage center for LLW has operated at Maquixco since 1972.

As of June 2016, Holtec was nearing completion of its turnkey project for installation and commissioning of an Independent Spent Fuel Storage Installation (ISFSI) at the Laguna Verde Nuclear Power Plant.



U.S. Government Collaboration

123 Agreement: Mexico does not have a 123 Agreement with the United States, although negotiations on text for a future 123 Agreement are on-going. A project supply agreement (PSA) between Mexico, the United States and the IAEA enables U.S. cooperation and trade with Mexico relating to the Laguna Verde NPP. The existing PSA will not apply to the potential Laguna Verde expansion.

Currently, technology transfers to Mexico associated specifically with the Laguna Verde NPP are “generally” authorized per the nuclear technology transfer regulations under 10 CFR Part 810 (Part 810). All other nuclear exports to Mexico require a “specific” authorization, requiring a case-by-case approval from the U.S. Secretary of Energy.

Regulatory Cooperation: The U.S. NRC and the National Nuclear Safety and Safeguards Commission of the United Mexican States (CNSNS) have an arrangement for the exchange of technical information and cooperation in nuclear safety and security matters. CNSNS has also signed agreements with the NRC to join the Code Applications and Maintenance Program (CAMP) and the Cooperative Severe Accident Research Program (CSARP).

U.S.-Mexico High Level Economic Dialogue (HLED): Established in 2013, the HLED is chaired by the U.S. Departments of Commerce and State, and the Mexican Ministry of Finance, with the goal of promoting bilateral economic competitiveness. Energy is one of the six HLED priority areas.

U.S.-Mexico Energy Business Council: In February 2016, the U.S. Department of Commerce announced the establishment of the [U.S.-Mexico Energy Business Council](#). The Council brings together

representatives of the U.S. and Mexican energy industries to discuss ways to strengthen commercial ties between energy industries in the two countries and communicate actionable, non-binding recommendations to the U.S. and Mexican governments.

Commercial Nuclear Executive Trade Mission to Mexico: On June 14-16, 2017, the Nuclear Energy Institute (NEI) organized a trade mission to Mexico to enable U.S. civil nuclear companies to assess market opportunities, develop local contacts and to visit Mexico’s existing nuclear power facility at Laguna Verde. The mission was organized in partnership with the U.S. Department of Commerce and the Mexican Secretariat of Energy (SENAR).

International Engagement

The U.S. and Mexico have had a bilateral science and technology agreement since 1972. Nuclear energy engagement is primarily with the IAEA.

Figure 21: Additional Agreements

Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention on Third Party Liability in the Field of Nuclear Energy	
Vienna Convention on Civil Liability for Nuclear Damage	✓
Joint Protocol Relating to the Application of the Vienna Convention and Paris Convention	✓
Convention on Supplementary Compensation for Nuclear Damage	
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	✓
OECD/NEA	✓
IFNEC	✓
GenIV International Forum (GIF)	
EURATOM	

Resources

For more information on the commercial opportunities in Mexico, contact: Francisco Ceron (Senior Trade Specialist, francisco.ceron@trade.gov); John Howell (Principal Commercial Officer in Monterrey, john.howell@trade.gov).

For more information on the civil nuclear industry in Mexico, contact: SOE website (www.sener.gob.mx); CFE website (www.cfe.gob.mx); CNSNS (www.cnsns.gob.mx)

Sources

CIA Factbook, U.S. Energy Information Administration, United Nations, World Nuclear Association, Asian Development Bank, and Commerce Department contacts at the U.S. Embassy in Mexico City.

Poland

Market Type: Newly Emerging

The Ministry of Energy has been working on a Polish Nuclear Power Plan (PNPP) revision, including preparation of a new financing model and an updated program schedule. The revised PNPP should be ready by the end of 2017. Currently, the government is considering construction of the first 1,000 – 1,600 MW nuclear power unit without financial support of a foreign strategic partner. The plant might be financed by Polish state-controlled companies and development funds. The government will be looking for a foreign nuclear reactor technology partner, and the reactor technology tender will be announced once the revised PNPP is in place.

Overall
Rank

#8

U.S. Ambassador to Poland: Paul W. Jones
U.S. Commerce Attaché to Poland: Charles R. Ranado

Market Overview

Poland currently has no operating nuclear power plants. Construction on four Russian VVER units began in the 1980s at Zarnowec in northern Poland, but they were canceled in 1990.

The current Polish Nuclear Power Program (PNPP) approved by the Polish government calls for construction of two NPPs comprising 6 GWe capacity by 2030. State-owned utility Polska Grupa Energetyczna (PGE) is doing site and characterization analysis for the first nuclear power plant at two locations in northern Poland: Zarnowec and Lubiatowo-Kopalino. PGE will make the final site selection decision in 2018. In April 2017, PGE EJ1 announced that Polish company ELBIS would begin carrying out environmental studies of the sites; final selection of location is expected by the end of 2017. The significantly delayed technology tender originally planned to be announced by the end of 2012, is still to be announced.

PGE set up the company PGE EJ1 to build and run the first plant. In September 2013, PGE entered into a shareholder agreement with the utilities Tauron Polska Energia and Enea as well as copper supplier KGHM Polska Miedz, wherein PGE holds 70 percent of PGE EJ1 and the other companies each hold 10 percent. A follow-on agreement with similar terms was signed in September 2014. In November 2015, PGE EJ1 said five companies had shown interest in the tender: GE- Hitachi (U.S.), KEPCO (ROK), SNC-Lavalin (Canada), Westinghouse (U.S.), and EdF/Areva (France).

Poland has also expressed interest in participating in an international project for the near-term deployment and commercialization of a high temperature gas cooled (HTGR) reactor. An HTGR could

potentially be cheaper than building a large reactor and could provide electricity generation and process heat for industrial use.

Planned Nuclear Energy Projects

First Nuclear Power Plant

Owner: PGE EJ1 consortium

Reactor Type: undetermined: technology selection by the end of 2017

Capacity: 3000 MWe

Value of Project: \$15 billion

Construction Period: Unit 1: Beginning in 2019

Operation (tentative): Unit 1: 2024

Second Nuclear Power Plant Project

Owner: PGE consortium

Reactor Type: undetermined

Capacity: 3000 MWe

Value of Project: \$15 billion

Construction Period: late 2020s to early 2030s

Operation (tentative): 2035

Opportunities

Services (front- and back-end): Feasibility studies; environmental analysis; regulatory assistance; infrastructure development; human resource development.

Legal and Consulting Services: Potential for pre-construction services.

Licensing Support: Potential for pre-construction services.

Design, Construction, and Operation: By mid-2017, the Polish government is expected to select the technology for its first NPP.

Components: None currently

Fuel Management: None currently

Waste Management: None currently

Challenges and Barriers

Poland's first reactor tender will attract stiff competition, but U.S. industry is well-positioned. The significant postponement of the country's first tender could prove to be beneficial to the U.S. industry, as it will give PGE more time to pursue viable financing options, which continues to be the biggest challenge to building NPPs in Poland. Construction costs are considered to be high and a serious burden on the State Treasury; these projected costs could impact state-owned companies' budgets. The Polish government is actively seeking means by which to resolve this challenge and plans to announce its financing plan for the first NPP in 2017.

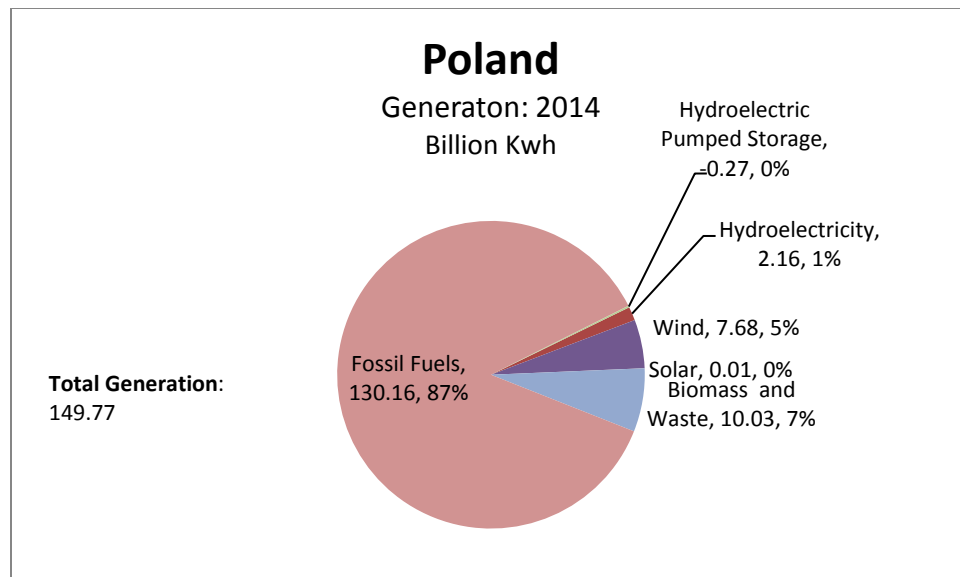
GOP commitment towards NPP construction is unclear given the new government's priorities for coal sector restructuring and investment in high efficient coal fired power plants. Public opinion is moderately favorable toward the country's nuclear build plans. The country faces numerous challenges in the energy sector, including falling electricity prices and changes in European energy market regulation.

Poland's ratification of the 1997 Protocol to the Vienna Convention will help reduce liability concerns for U.S. industry, and its favorable EXIM Bank Long-Term Exposure Fee Level should provide a boost for U.S. industry competitiveness.

Nuclear Infrastructure

Research Reactor: The research reactor Maria, also used for production of medical radioisotopes and operated in Swierk (National Centre for Nuclear Research) is the only operating nuclear facility in the country.

Waste Management: The State Enterprise for Neutralization of Nuclear Waste (ZUOP) is associated with the management of waste produced by the research reactor. Poland has one operational repository, National Radioactive Waste Repository Różan, which allows for the disposal of low and intermediate level waste. However, this will be full no later than 2022, necessitating the design and construction of a new waste repository.



U.S. Government Collaboration

123 Agreement: Nuclear cooperation between the United States and Poland falls under the framework of the U.S.-EURATOM 123 Agreement, which expires in 2026 with rolling five-year extensions possible thereafter.

Joint Declaration on Civil Nuclear Commercial Cooperation: In July 2010, the Department of Commerce (DOC) and Poland's Ministry of Economy signed a Joint Declaration Concerning Industrial and Commercial Cooperation in the Nuclear Energy Sector.

July 2011 Trade Policy Mission: In July 2011, DOC's Under Secretary for International Trade led a civil nuclear trade policy mission with 11 U.S. civil nuclear companies to Poland, the Czech Republic and Slovakia.

U.S.-Poland Economic and Commercial Dialogue: Initiative between DOC and the Polish Ministry of Economy to promote bilateral trade and investment and further bilateral economic and commercial relations.

Regulatory Cooperation: The U.S. NRC and the National Atomic Energy Agency of the Republic of Poland (PAA) have an arrangement for the exchange of technical information and cooperation in nuclear safety and security matters. PAA has also signed agreements with the NRC to join the Code Applications and Maintenance Program (CAMP) and the Cooperative Severe Accident Research Program (CSARP).

International Engagement

Poland has been involved in several regional nuclear projects, including the Olkiluoto 2 NPP project in Finland and a joint NPP project with Latvia, Estonia and Lithuania. PGE withdrew from the latter initiative in December 2011 to focus on its NPP development. In March 2015, Ukrenergo (Ukraine), Energoatom (Ukraine), and privately-owned Polish company Polenergia signed an agreement to export Ukrainian nuclear energy in support of the Ukraine-European Union “energy bridge” project. Revenues from the exports will fund nuclear power plant projects in Ukraine.

Additional Agreements	
Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	✓
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	
Paris Convention Liability Agreement	
Vienna Convention Liability Agreement	✓
Joint Protocol Liability Agreement	✓
Convention on Supplementary Compensation for Nuclear Damage	
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	✓
OECD/NEA	✓
IFNEC	✓
GenIV International Forum (GIF)	
EURATOM	✓

Resources

For more information on the commercial opportunities in Poland, contact: Charles R. Ranado (Senior Commercial Officer in Warsaw, charles.ranado@trade.gov); Kenneth Duckworth (Commercial Officer in Warsaw, Kenneth.duckworth@trade.gov); Aleksandra Prus (Commercial Specialist in Warsaw, aleksandra.prus@trade.gov).

For more information on the civil nuclear industry in Poland, contact: PGE website (<http://www.gkpge.pl/>); PAA website (<http://www.paa.gov.pl/>)

Sources

CIA Factbook, United Nations, World Nuclear Association and ITA contacts at U.S. Embassy Warsaw.

Saudi Arabia

Market Type: Newly Emerging

Saudi Arabia has ambitious plans to diversify its energy sources by 2040, possibly including the construction of large nuclear reactors. Since 2010, Saudi Arabia has expressed interest in nuclear power for electricity generation, desalination and long-term R&D, as well as small and advanced reactor designs. Goals for nuclear energy, however, have not progressed beyond the planning stage, and the lack of a 123 Agreement could hinder U.S. exports in the future.

Overall
Rank

#9

Chargé d’Affaires to Saudi Arabia: Paul W. Jones
U.S. Commerce Attaché to Saudi Arabia: Nasir Abbasi

Market Overview

Saudi Arabia currently has no nuclear reactors in operation or under construction but is considering building an unspecified number of reactors and adding nuclear power to its power generation mix by 2040. In 2011, Saudi Arabia proposed adding 17 GWe of nuclear power, approximately 16 reactors, by 2040 valued at over \$80 billion. Saudi Arabia hired WorleyParsons in 2011 to conduct an analysis of potential sites and assist with preparing a tender. Three potential sites were short-listed in September 2013. Since then, these plans have not yet materialized and a realistic near-term outcome would be the construction of two units over the next ten years. The King Abdullah City for Nuclear and Renewable Energy (KA-CARE) has stated that the country’s goals for developing a civil nuclear program are to meet its growing electricity requirements, produce desalinated water, and reduce reliance on hydrocarbons. The Saudi Arabian government’s Power Sector Generation Strategy calls for 3 GWe of nuclear energy by 2040.

Saudi Arabia’s nuclear build plans have attracted significant interest internationally. In September 2013, GE-Hitachi and Toshiba-Westinghouse signed contracts with Exelon to pursue reactor construction in Saudi Arabia. In January 2014, Areva and EdF signed agreements with Saudi Arabia’s Global Energy Holding Company (GEHC) to conduct a feasibility study for an EPR.

Saudi Arabia has expressed interest in cooperation on small reactors and Generation IV designs. In March 2015, Saudi Arabia’s Taqnia and Argentina’s INVAP formed a joint venture called Invania to cooperate on Argentina’s small modular reactor design, CAREM, for desalination applications in Saudi Arabia. In March 2015, KA-CARE also signed a memorandum of understanding with the Korea Atomic Energy Research Institute (KAERI) to investigate co-developing and building two 100 MWe SMART reactors. In September 2015, the two partners further signed a cooperation agreement and contracts to start a three-year preliminary study to review the feasibility of constructing SMART reactors in Saudi Arabia. In January 2016, KA-CARE and China Nuclear Engineering Corporation (CNEC) signed a memorandum of understanding on the construction of a high-temperature gas-cooled reactor. In March

2017, the two countries signed a cooperation agreement for a joint study on feasibility of construction of HTGRs in the Kingdom, with the feasibility study beginning in May 2017. Furthermore, since the signing of the MOU, both countries have begun discussion of site selection, development of a regulatory system, and personnel training.

Opportunities

Services (front- and back-end): Possibilities for additional site selection and feasibility studies, regulatory assistance, infrastructure development, human resource development.

Legal and Consulting Services: Potential for pre-construction services.

Licensing Support: Potential for pre-construction services.

Design, Construction, and Operation: First tender is expected in the next few years. Currently, GE-Hitachi, Westinghouse, Areva/EdF, Rosatom, KEPCO and CNNC have shown interest in competing for this project.

Components: Opportunities once reactor technology has been chosen.

Fuel Management: None currently.

Waste Management: None currently.

Challenges and Barriers

Market access is a challenge due to the strength of foreign competition. France, China, the Republic of Korea and Russia have all shown interest in Saudi Arabia's expected tenders and have signed cooperation agreements for feasibility studies, regulatory assistance, training and R&D. Saudi Arabia's plans for nuclear power could be scaled up quickly depending on how it pursues its goal of diversifying its energy mix.

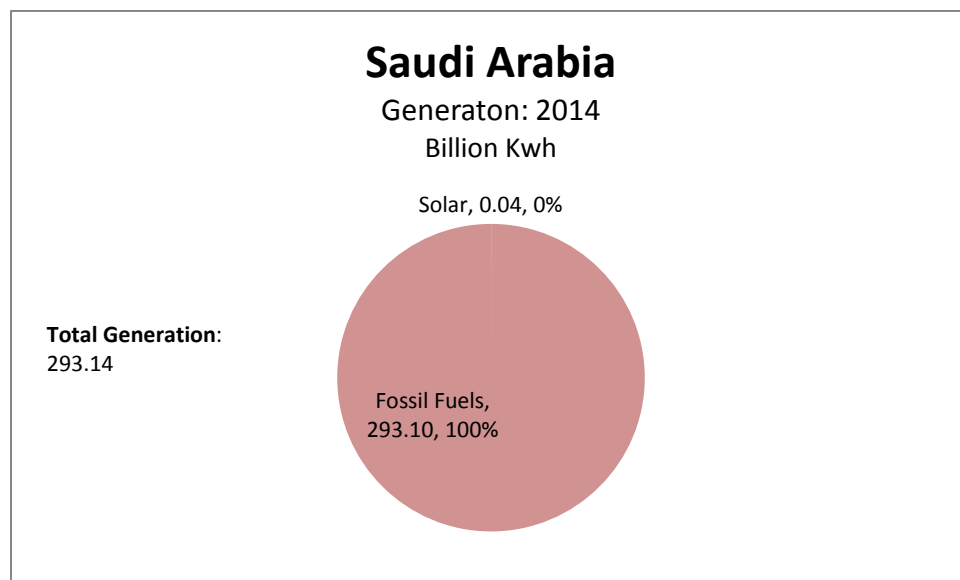
The government is committed to establishing a nuclear regulatory authority. This effort is headed by KA-CARE, which works with the Finnish safety authority, STUK, as its strategic partner.

Saudi Arabia is party to the 1997 Protocol to the Vienna Convention on nuclear liability. The entry into force of a 123 Agreement would open doors for U.S. exports. Saudi Arabia scores high on all financial indicators.

Nuclear Infrastructure

Research reactors: None at present, although KA-CARE has agreed to buy a small research reactor from Argentina.

Fuel: In March 2017, China National Nuclear Corporation (CNNC) and the Saudi Geological Survey signed a memorandum of understanding on cooperation in the exploration of uranium; over the next two years they will explore nine potential areas in the Kingdom for uranium resources. Saudi Arabia also signed an agreement with Jordan in March 2017 covering exploration and mining of uranium in central Jordan. Further, a memorandum of understanding was signed whereby a feasibility study will be conducted on the construction of two small modular reactors (SMRs) for generation of electricity and desalination of water in Jordan.



U.S. Government Collaboration

123 Agreement: Saudi Arabia does not have a 123 Agreement with the United States.

Bilateral Engagement: Interest in exports and cooperation in the nuclear sector date to 2008, when the U.S. and Saudi Arabia signed an MOU on Civil Nuclear Energy Cooperation. In November 2012, the U.S. Chamber of Commerce and the U.S.-Saudi Business Council sent a delegation to Saudi Arabia to discuss nuclear and solar technology developments.

International Engagement

Saudi Arabia is cooperating with Argentina on a small scale reactor for research and desalination. It has signed cooperation agreements with France, China, Finland, Hungary, the Republic of Korea, and Jordan, and is pursuing agreements with Russia, Czech Republic and the UK.

Additional Agreements	
Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	
Joint Convention on Safety of Spent Fuel Management	✓
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention Liability Agreement	
Vienna Convention Liability Agreement	✓
Joint Protocol Liability Agreement	
Convention on Supplementary Compensation for Nuclear Damage	
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	
OECD/NEA	
IFNEC	✓
GenIV International Forum (GIF)	
EURATOM	

Resources

For more information on the commercial opportunities in Saudi Arabia, contact: Mr. Gary Rand (Principal Commercial Officer in Dhahran, gary.rand@trade.gov).

For more information on Saudi Arabian civil nuclear energy, consult: K.A. CARE website: <https://www.kacare.gov.sa/en>

Sources

CIA Factbook, United Nations, World Nuclear Association, Asian Development Bank, and ITA contacts at the U.S. Embassy in Riyadh and U.S. Consulates in Dhahran and Jeddah.

Turkey

Market Type: Newly Emerging

Turkey is planning to build 12 reactors at three sites. A Russian consortium was chosen to build the first four reactors on a build-own-operate model, and a Mitsubishi-Areva consortium is in discussions for the next four reactors. China's SNPTC and U.S. firm Westinghouse are in discussions for the third project. The potential for U.S. exports will depend on Turkey's plans for its third plant. Challenging political and economic conditions in Turkey have delayed decision-making on all of these projects.

Overall
Rank

#10

U.S. Ambassador to Turkey: John R. Bass
U.S. Commercial Counselor: Larry Farris
Senior Energy Specialist: Serdar Cetinkaya

Market Overview

Turkey currently has no operating nuclear power plants (NPPs), but it plans to construct new NPPs in order to meet growing electricity demand and reduce its dependence on imported energy resources such as natural gas (largely coming from Russia and Iran). It is currently planning 12 reactors at three sites: Akkuyu on the Mediterranean coast, Sinop on the Black Sea coast and İğneada near the Bulgarian border.

A Russian consortium will build four VVER-1200 reactors with an output of 4800 MWe at Akkuyu on a build-own-operate (BOO) model to include fuel supply and spent fuel take-back. Russia previously pledged to fully finance the project at over \$20 billion but signed a preliminary agreement on June 19, 2017, to sell a 49 percent stake to a Turkish consortium consisting of Cengiz, Kalyon, and Kolin (the shareholders' agreement will be signed in 2017). Tension in Russia-Turkey relations had delayed the project, but in June 2017, Turkey's Energy Market Regulatory Authority (EPDK), granted a power generation license to Rosatom to construct the reactors, two of which are now expected to be completed by 2023 and to provide 6-7 percent of Turkey's electricity demand. The Turkish government has stated that it will classify the Akkuyu project as a strategic investment, allowing for favorable tax treatment.

Turkey is also working with a consortium led by Japan's Mitsubishi and France's Areva to build four Atmea1 reactors in Sinop province, totaling 4800 MWe. In 2013, Japan and Turkey signed an agreement to allow Japan "exclusive negotiating rights to build a nuclear power plant". Feasibility studies are expected to conclude in late 2017, with construction on the first unit in 2017 with operation in 2023.

In November 2014, U.S. nuclear technology company Westinghouse (WEC) signed an agreement with China's State Nuclear Power Technology Corporation (SNPTC) and Electricity Generation Company (EÜAŞ), Turkey's state-owned and largest electric power company, to enter into "exclusive negotiations"

to develop and construct an additional nuclear power station in Turkey. The agreement covers the entire life cycle of the project; from construction to decommissioning. It is assumed that the first two units will be WEC AP-1000 reactors, with Chinese CAP-1400 reactor technology being utilized for the subsequent two units. In October 2015, the likely site was identified as İğneada, a town on the Black Sea near the Bulgarian border, although other sites are still under evaluation. Discussions on the development of the project continue among WEC, SNPTC and EÜAŞ, and a final decision on the project model has not been made.

Planned Nuclear Energy Projects

Akkuyu Nuclear Power Plant

Owner: Akkuyu NPP JSC (Russia majority controlled as a BOO model)

Reactor Type: VVER-1200 (AES-2006) with a 60-year lifetime

Capacity: 4800 MWe (4 units, 1200 MWe each) *Value of Project:* \$20-25 billion dollars; \$1.3 billion was budgeted for 2013

Construction Period: 2017-2025

Operation: 2023 for first two reactors

Agreements with Russia Regarding Akkuyu: Russia will be responsible for obtaining licenses and permits, financing, training of Turkish personnel, design, construction, operation and maintenance, supply of equipment and material, and supply of nuclear fuel. There is a take-back option for the reprocessing of spent fuel by Russia. Turkey is responsible for the allocation of the plant site with its current license without any cost and purchasing electricity according to a Power Purchase Agreement. The Rosatom agreement for Akkuyu also provides for setting up a fuel fabrication plant in Turkey.

Sinop Nuclear Power Plant

Owner: Mitsubishi Heavy Industries (Japan)-AREVA (France) joint venture: both companies are state-owned; GdF-Suez would be the operator of the eventual plant

Reactor Type: ATMEA1 with a 60 year lifetime; these will likely be the first ATMEA1 units built

Capacity: 4800 MWe (4 units)

Value of Project: \$22-25 billion

Construction Period: First unit 2018-2023; other units TBD.

Operation (tentative): First unit in 2024

Agreements with Mitsubishi-AREVA Regarding Sinop: Turkey signed an agreement with Japan in 2013 giving the Japanese government exclusive negotiating rights for building the plant. The agreement was approved by Turkish President Erdoğan in April 2015 after being ratified by the Parliament a month earlier.

İğneada NPP

Owner: TBD. Turkish utility EÜAŞ is in discussions with China's SNPTC and U.S. firm Westinghouse.

Reactor Type: TBD. Early indications are for two WEC AP1000s and two SNPTC CAP1400s.

Capacity: 4800 MWe (4 units)

Value of Project: \$20+ billion

Construction Period: Unknown

Operation: Unknown

Agreements with SNPTC and WEC Regarding İğneada: In November 2014, SNPTC, WEC and EÜAŞ signed an agreement to begin “exclusive negotiations”. During a March 2016 visit to China, Turkish Energy Minister Albayrak toured the AP1000 under construction in Haiyang and was briefed on the CAP1400 design. Discussions are ongoing. A nuclear cooperation agreement with China was accepted by Turkey’s Council of Ministers in August 2016.

Opportunities

Services (front-and back-end): There may be opportunities for U.S. firms if the İğneada plant is developed. Local Turkish firms are seeking for U.S. component manufacturers to be joint venture partners in the supply and contracting work of all current and future projects. Most opportunities are likely to be for component manufacturers.

Legal and Consulting Services: Moderate potential opportunities for regulatory consulting related to the Akkuyu project. The Turkish Atomic Energy Agency (TAEK) may seek technical consultancy for the Sinop and İğneada plants. Most opportunities will be composed of engineering, legal and regulatory consulting services.

Licensing Support: Moderate potential to support Turkey’s nuclear safety regulator TAEK, especially regarding regulatory consulting.

Design, Construction, and Operation: Opportunities exist for site surveys, preliminary and detailed design, environmental impact assessment study, feasibility study, financing and auxiliary equipment production and supply.

Fuel Management: None currently

Waste Management: None currently

Challenges and Barriers

Despite Turkey’s new build plans, opportunities for U.S. industry have been limited. Turkey’s insistence on a spent fuel take-back option for Akkuyu forced out all competitors except the Rosatom consortium that eventually won the bid. For Sinop, Turkey has negotiated directly with countries or companies rather than launch an open bid. These have included Korea and Canada (both of whom withdrew over financing issues), China and Mitsubishi-Areva, who is now expected to build the plant. The November 2014 agreement between WEC, SNPTC and EÜAŞ is a positive development for U.S. industry participation in Turkey’s third plant.

Turkish government support for new builds is strong, though Turkey is taking a measured pace toward projects beyond Akkuyu and Sinop. A 123 Agreement exists between the United States and Turkey, and Turkey is party to the Paris Convention for nuclear liability.

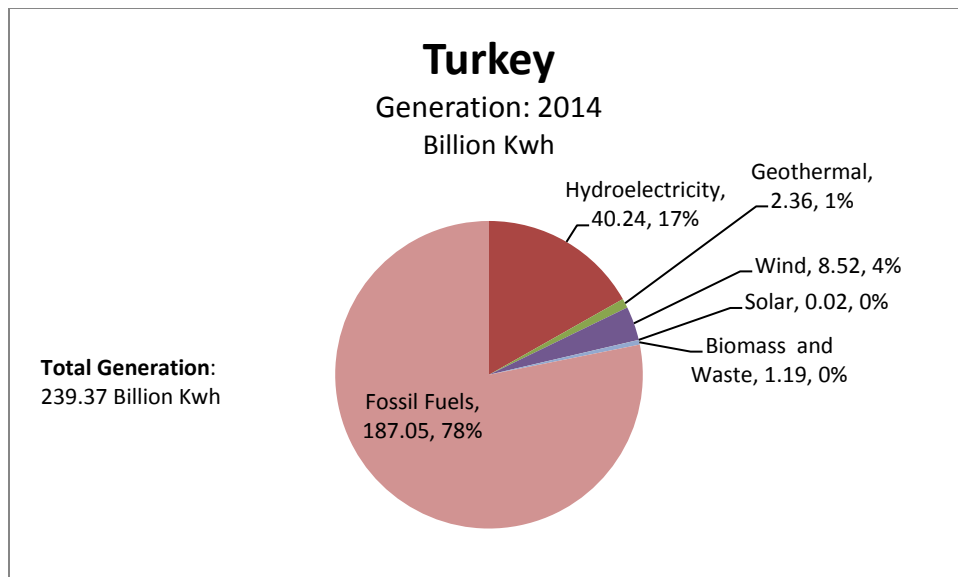
Financing, however, is a challenge. Turkey has limited means for financing nuclear power projects on its own, as evidenced by the BOO model it has agreed to for Akkuyu. In addition to financing issues, there are concerns about earthquake damage to reactors and political instability in eastern Turkey.

Nuclear Infrastructure

Research Reactor: Turkey has a small Triga research reactor at Istanbul Technical University. It has operated since 1979 and is regulated by TAEK.

Fuel: Turkey possesses approximately 7,400 tU of uranium resources. The government is evaluating the mining operation license application of a U.S. firm which has found reserves of uranium in the province of Sivas. Developing its domestic resources has been an emphasis of the Turkish government. Production at the Temrezli uranium project could begin as early as mid-2017, pending government project approvals, which stalled the project in 2016.

Waste Management: Waste management is mainly limited to radioactive waste arising from the industrial and medical applications of nuclear technologies, and there is a facility for interim storage of these wastes. This storage facility was built and has been operating, since 1989, in the ÇNAEM. Compaction, cementation and precipitation processes have been carried out at this facility. TAEK originally required that reactor vendors reclaim used fuel, but in the case of Akkuyu, decisions still need to be made regarding whether waste will remain in Turkey or be repatriated to Russia.



U.S. Government Collaboration

123 Agreement: The 123 Agreement with the United States entered into force in June 2008 and has an initial term running through June 2023 with rolling five-year extensions to follow.

Regulatory Cooperation: The U.S. NRC and the Turkish Atomic Energy Authority (TAEK) have an arrangement for the exchange of technical information and cooperation in nuclear safety and security matters.

International Engagement

Turkey has voluntarily accepted to join the EU stress tests program, demonstrating Turkey's commitment to the adoption and implementation of the most rigorous safety standards in the construction and operation of its nuclear power plants. In June 2010, Turkey and Korea signed a nuclear cooperation agreement, and in April 2012, two such agreements with China were signed. TAEK is participating in the IAEA-coordinated International Project on Innovative Nuclear Reactor Technologies and Fuel Cycles (INPRO). TAEK also contributes to the studies and projects of the OECD/NEA working groups. Turkey has an observer status for CERN, the European Organization for Nuclear Research, which is the world's leading laboratory for particle physics. All activities in Turkey are coordinated and sponsored by TAEK under the auspices of the Ministry of Energy and Natural Resources. Turkey is a member of the Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME), an international scientific research center under construction near Amman, Jordan.

Additional Agreements	
Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention Liability Agreement	✓
Vienna Convention Liability Agreement	
Joint Protocol Liability Agreement	✓
Convention on Supplementary Compensation for Nuclear Damage	
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	✓
OECD/NEA	✓
IFNEC	✓
GenIV International Forum (GIF)	
EURATOM	

Resources

For more information on the commercial opportunities in Turkey, contact: Larry Farris (Commercial Counselor in Ankara); Serdar Cetinkaya (Senior Energy Specialist in Ankara, serdar.cetinkaya@trade.gov).

For more information on the civil nuclear industry in Turkey, see: EÜAŞ website (<http://www.euas.gov.tr/>); ETKB website (<http://www.enerji.gov.tr/>); TAEK (<http://www.taek.gov.tr/>).

Sources

CIA Factbook, United Nations, World Nuclear Association and the U.S. Embassy in Ankara and U.S. Consulate in Istanbul.

Ukraine

Market Type: Newly Emerging

Ukraine possesses a robust civil nuclear energy program, which accounts for almost half of its energy mix. Ukraine relies heavily on Russia for most aspects of its program. The Ukrainian government, however, is attempting to expand its energy supply by seeking non-Russian sources of nuclear fuel and construction materials for fuel fabrication plants. Ongoing Ukrainian-Russian tension has increased Ukraine's efforts to reduce its dependence on Russia, which could offer opportunities for U.S. industry.

Overall
Rank

#18

U.S. Ambassador to Ukraine: Marie L. Yovanovitch

U.S. Commerce Attaché to Ukraine: James Lindley

Market Overview

Almost half of Ukraine's energy is generated by its 15 Russian-designed nuclear reactors located at four plants: Khmelnytsky, Rivne, South Ukraine and Zaporozhe. The reactors are operated by the country's state-owned nuclear power utility, NNEGC Energoatom. Ukraine is prioritizing foreign involvement in its nuclear sector to reduce dependence on Russia.

Most of Ukraine's nuclear fuel and nuclear services are supplied by Russia. In the last few years, Ukraine has diversified its fuel supply by purchasing fuel from Westinghouse. In April 2015, Energoatom signed a contract with Areva for the supply of enriched uranium to be used in Ukraine's nuclear power plants (NPPs). In November 2015, Energoatom signed a Memorandum of Understanding (MOU) with Areva to cooperate on safety upgrades, lifetime extensions, and performance optimization of the existing fleet and future nuclear power plants (NPPs). This agreement covers areas such as reactor maintenance and inspection, outage optimization, electric systems, filtered containment venting systems, and management of obsolete material and equipment. In March 2016, Westinghouse signed a memorandum of understanding with PJSC Turboatom to increase the capacity of 13 VVER-1000 turbine generator sets by up to 110 percent of the nominal level. In 2016, Ukraine imported 28.3 percent of its nuclear fuel from Westinghouse (Sweden). In 2017, Ukraine plans to increase the supply of Westinghouse nuclear fuel.

The new Ukrainian government has shown considerable interest in prioritizing Western-designed nuclear reactors. Due to the long construction time required for new reactor construction and high government debt levels, however, refurbishment and lifetime extensions of the current fleet are more likely. Ukraine expects to increase the share of nuclear power in its electricity mix from 52 percent to 55 percent by 2020. In 2006, following disruptions in its natural gas supply, Ukraine decided to double its nuclear capacity to ensure greater energy security. Ukraine currently has nuclear cooperation

agreements with several countries, including the United States and Canada, and with the European Atomic Energy Community (EURATOM).

Planned Nuclear Energy Projects

Khmelnitsky Nuclear Power Expansion

Owner: State

Reactor Type: V-392

Capacity: 2000 MWe (2 units, 1000 MWe each)

Value of Project: N/A

Construction Period: N/A

Operation: N/A

Khmelnitsky NPP: Two reactors at the Khmelnitsky site have been under construction since 1986. Construction stopped in 1990 after the Chernobyl accident led to a moratorium on new NPP construction in Ukraine. Ukraine's new nuclear power strategy has focused on finishing construction on Khmelnitsky 3 and 4, which restarted in 2010 after a new deal was signed with Russia. Although the reactors were initially to be constructed by Russia's Atomstroyexport, the intergovernmental agreement was revoked due to Atomstroyexport's non-performance, thus Ukraine sought to transfer the contract to the Czech Republic's Skoda JS. However, in August 2016, Energoatom and Korea's KHNP signed a Memorandum of Understanding whereby both countries would agree to cooperate in the nuclear energy sector, including the completion of Khmelnitsky 3 and 4 and the project "Energy Bridge Ukraine – European Union".

Opportunities

Services (front-and back-end): Although three nuclear plants are scheduled to close in 2016 to 2017, life extensions are more probable. Few decommissioning opportunities exist beyond ongoing Chernobyl activities.

Legal and Consulting Services: Opportunities exist as Ukraine tries to meet new European NPP safety standards and works toward introducing more foreign companies into its nuclear industry.

Design, Construction, and Operation: Opportunities may exist for construction of reactors, particularly with ongoing tension between Ukraine and Russia. Value added can be found in upgrading, rehabilitation and life extension of existing plants.

Fuel: Significant opportunities exist for supplying fuel to Ukraine's current fleet as it seeks diversification away from Russian sources.

Components: Some opportunities exist for supplying the current Russian-designed fleet.

Challenges and Barriers

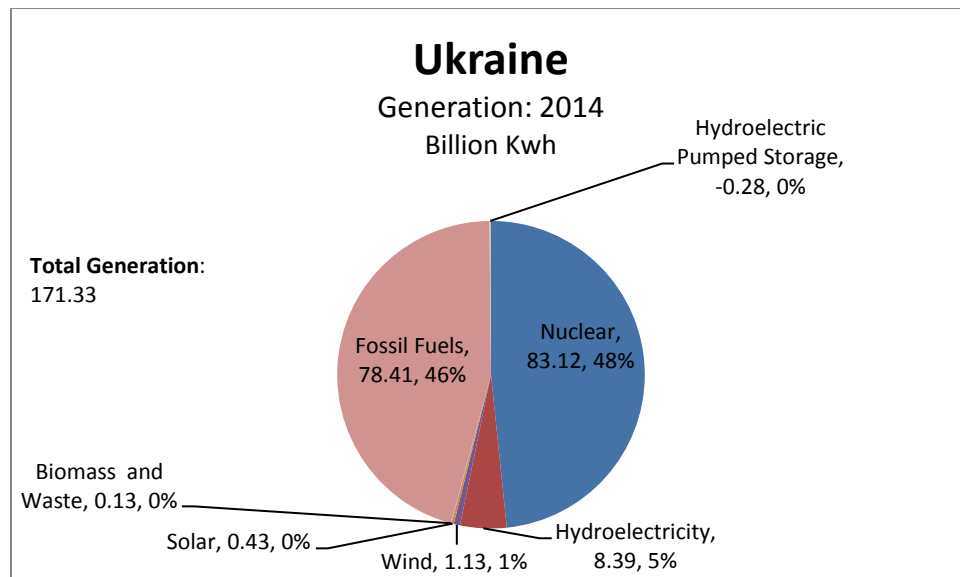
The primary challenge to U.S. civil nuclear exports is the strong presence of Russia in the Ukrainian market. All of Ukraine's 15 reactors are of Russian design, and the country has historically been dependent on Russia for nuclear. The growing Ukrainian government debt may pose a challenge to nuclear exports given that Energoatom is state-owned.

Nuclear Infrastructure

Research reactors: There are two pool type research reactors in Ukraine. The Kyiv research reactor belongs to the Ukrainian Academy of Sciences and has 10 MW nominal capacities. The Sevastopol research reactor belongs to the Sevastopol National University of Nuclear Energy and Industry and has 200kW capacity, but it is located in the disputed territory of Crimea. Energoatom stated that it could not accept responsibility for the reactor as it no longer has access to it. In 2012, the Ukrainian government approved construction of the Kharkiv Institute of Physics and Technology Experimental Neutron Source Facility, an accelerator system for research in nuclear physics, with cooperation from Oak Ridge and Idaho National Laboratories. The final stage of preparations for making the facility operational began in March 2016.

Fuel: Ukraine does not convert, enrich or fabricate its fuel. There are mining and uranium resources, including approximately 2 percent of the world's uranium reserves. Uranium concentrate and zirconium alloy are sent to Russia for enrichment and further production of nuclear fuel, which is then shipped back to Ukraine. Ukraine and Russia have continued this arrangement, though Ukraine has attempted to buy more of its fuel from non-Russian sources.

Waste Management: Ukraine has an open fuel cycle. It has two storage facilities for spent fuel, dry at the Zaporozhye plant and wet at the Chernobyl plant. Spent fuel is also currently sent back to Russia. Plutonium and high-level waste were expected to be returned to Ukraine from Russia, but this has not yet taken place. In January 2015, Energoatom and U.S. firm Holtec signed a contract to construct a central used fuel storage facility in the Chernobyl Exclusion Zone, with site construction work to be finished by slated to be completed by mid-2018 and set to be fully-operational and begin receiving spent fuel in 2019.



U.S. Government Collaboration

123 Agreement: Ukraine has a 123 Agreement with the United States, which entered into force in May 1999 and is due to expire on May 28, 2029.

U.S.-Ukraine Energy Security Working Group: DOE/NE acts as the head of the civil nuclear energy sub-group within the larger working group under the U.S. Department of State and the Ukrainian Ministry of Energy and Coal Industry (MECU).

Memorandum of Understanding: The U.S. and Ukraine have a memorandum of cooperation on several energy issues, including nuclear security.

Regulatory Cooperation: The U.S. NRC and the State Nuclear Regulatory Inspectorate of Ukraine (SNRIU) have an arrangement for the exchange of technical information and cooperation in nuclear safety and security matters. SNRIU has also signed agreements with the NRC to join the Code Applications and Maintenance Program (CAMP) and the Cooperative Severe Accident Research Program (CSARP).

International Engagement

Although Ukraine is not a part of the EU, it is part of the European Energy Community and subject to laws governing the energy sector set forth by the European Commission. Therefore, as a precondition for EU investment, any non-EU reactor design built in the EU must have a diverse fuel supply from more than one source. Thus, Ukraine is actively working to diversify its fuel supply and lessen its dependence on Russia in meeting its needs in the nuclear sector. In August 2016, the Ukrainian government began

talks with Kazakhstan’s Energy Ministry and Kazatomprom in establishing a joint venture for uranium mining in both countries, as well as fuel fabrication program due to previous failure in plans to build a fuel fabrication plant in Ukraine. In March 2016, Governments of Australia and Ukraine agreed to cooperate in the peaceful use of nuclear energy, allowing for Australian uranium to be used as fuel in Ukrainian NPPs, further diversifying its nuclear fuel supply.

Additional Agreements	
Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	✓
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention Liability Agreement	
Vienna Convention Liability Agreement	✓
Joint Protocol Liability Agreement	✓
Convention on Supplementary Compensation for Nuclear Damage	
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	✓
OECD/NEA	
IFNEC	✓
GenIV International Forum (GIF)	
EURATOM	

Resources

For more information on the commercial opportunities in Ukraine, contact: James Lindley (Senior Commercial Officer in Kiev, james.lindley@trade.gov); Myroslava Myrtsalo (Commercial Specialist, myroslava.myrtsalo@trade.gov); Jonathan Chesebro (I&A Civil Nuclear Team, jonathan.chesebro@trade.gov)

For more information on the civil nuclear industry in Ukraine:

NNEGC Energoatom: <http://www.energoatom.kiev.ua/en/>

State Nuclear Regulatory Inspectorate of Ukraine (SNRC): <http://www.snrc.gov.ua/nuclear/en/index>

Ministry of Energy and Coal Industry of Ukraine MECU: <http://mpe.kmu.gov.ua/>

Sources

CIA Factbook, United Nations, World Nuclear Association, and ITA contacts at the U.S. Embassy in Kiev.

United Arab Emirates

Market Type: Newly Emerging

Since initiating its nuclear energy program in 2008, the UAE has moved swiftly to work with foreign exporters for its first nuclear power plant. A deal with a KEPCO-led consortium is providing the UAE's first four reactors at Barakah. The chief obstacle for U.S. civil nuclear companies in the UAE is robust and well-established foreign competition, but U.S. industry is well-positioned overall to provide well-financed subcontracting services.

Overall
Rank

#4

U.S. Ambassador to the United Arab Emirates: Barbara A. Leaf

U.S. Commerce Attachés to the United Arab Emirates: Nasir Abbasi (U.S. Commercial Attaché, Dubai), Dao M. Le (U.S. Commercial Counselor, Abu Dhabi)

Market Overview

The UAE is currently building its first four nuclear reactors at the Barakah site. The reactors are the Korean designed APR-1400. The first was originally due to come online in 2017, but startup has been delayed until early 2018 to ensure the plant and its operators meet safety and proficiency standards. The final plant is scheduled for completion by 2020. Despite the recently announced delay on Barakah-1, which is 95 percent complete to date, development and construction of the other three reactors have thus far followed the development schedule, signaling early success in an environment where many projects around the globe are delayed, often by years.

The UAE's electricity demand is growing rapidly, about 9 to 10 percent per year, its desalination demand is growing at about 8 percent per year, and the country is making strategic investments in new generating capacity. Almost all of its current electricity generation comes from fossil fuels, and its development of nuclear energy is an attempt to reduce its dependence on oil and gas for domestic consumption. Nuclear energy is expected to make up a substantial portion of the country's electricity generating capacity by 2030, requiring additional reactors beyond the four at Barakah. The UAE plans to export its nuclear-generated electricity as well.

The Federal Authority of Nuclear Regulation (FANR), established in October 2009, is the country's regulator. In November 2009, the UAE established the Emirates Nuclear Energy Corporation (ENEC), a public entity, to implement its civil nuclear plans and conduct site evaluations, technology selection and submission of the construction license application for the Barakah site. ENEC initiated the delay of the Barakah-1 startup, establishing that the site cannot load fuel or initiate startup until an operating license is issued by FANR and an independent assessment is conducted by IAEA and the World Association of Nuclear Operators (WANO). FANR has stated that it expects to issue an operating license for Barakah-1 in 2017.

In October of 2016, ENEC and the Korea Electric Power Corporation (KEPCO) signed a joint venture agreement establishing a long-term partnership, including the set-up of Barakah One PJSC, an independent subsidiary owned by both companies, to represent the commercial and financial interests of the nuclear power plant project. The agreement entitles KEPCO to an 18 per cent stake in ENEC's subsidiary, Nawah Energy Company, which was established in 2016 with the mandate to operate and maintain the Barakah nuclear power plant (NPP).

The UAE has expressed openness to “joint-venture agreements” between other countries for the construction and operation of future NPPs, as it has done with the Korean Electric Power Company (KEPCO). In its efforts to rapidly implement projects, the UAE has initially modeled its nuclear industry to operate primarily on contractor services as it slowly invests in and builds local expertise. Through this model, NPPs will be 60 percent owned by the government, and 40 percent owned by private sector partners. By 2020, 12 percent of Dubai's electricity supply capacity is expected to be nuclear.

Planned Nuclear Energy Projects

Owner: Nawah Energy, a joint venture of ENEC and KEPCO

Reactor Type: Type: APR-1400 reactors

Capacity: 5600 MWe (1400 x 4 reactors)

Value of Project: \$20.4 billion, with a high percentage of the contract being offered under a fixed-price arrangement. The consortium also expects to earn another \$20 billion by jointly operating the reactors for 60 years. In March 2010, KEPCO awarded a \$5.59 billion construction contract to Hyundai and Samsung for the first plants.

Construction Period: Construction began on one reactor per year from 2012 to 2015.

Operation: First reactor projected to come online in 2018, with the additional three reactors coming online by 2020.

Agreements with U.S. Industry: U.S. firms are providing significant support to the UAE's civil nuclear program. Westinghouse is part of the winning KEPCO team and is providing major components, instrumentation and control equipment, and design and technical and engineering support services. Lightbridge Corporation has provided consulting services to the UAE on the design, development and management of the key elements required to implement a nuclear energy program based on the highest international standards. CH2M Hill won a 10-year contract to manage the UAE's nuclear program in October 2008.

Opportunities

Services (front-and back-end): Limited potential for site selection, regulatory assistance, or other advisory services.

Legal and Consulting Services: Limited potential.

Licensing Support: Limited potential.

Design, Construction, and Operation: Opportunities for future NPP sites and small modular reactors (SMRs).

Challenges and Barriers

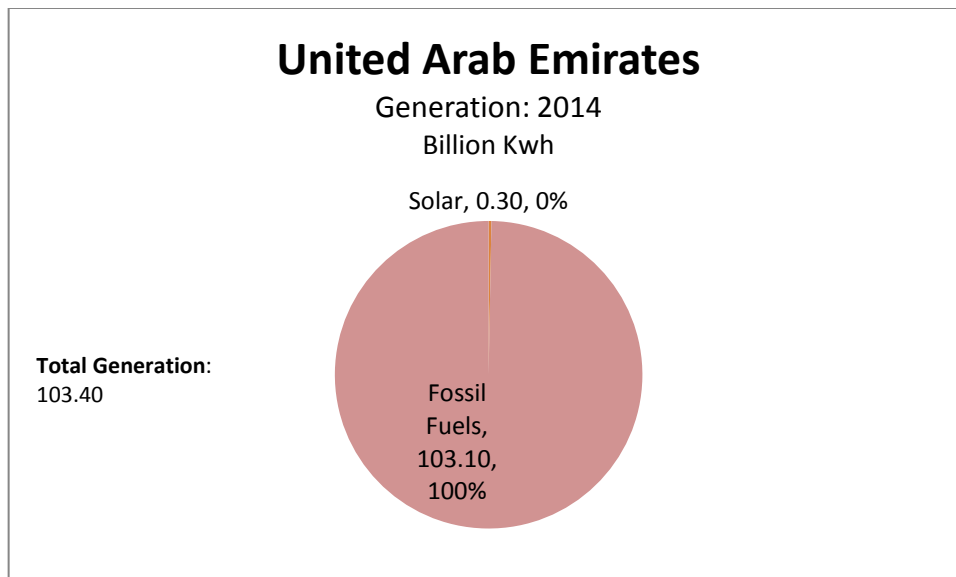
The UAE has moved swiftly and assuredly to implement its nuclear energy program. From the announcement of its first nuclear energy policy in 2008 to the awarding of the Barakah tender to KEPCO in December 2009, to the beginning of construction in 2012, the UAE government has shown strong support for and successful deployment of nuclear energy. The UAE has relied heavily on foreign industry for a variety of goods and advisory services and has planned for the support of foreign industry going forward in its nuclear program. Despite losing the reactor technology bid for the Barakah plant, U.S. industry has had a high level of involvement. This promises to remain the case for years to come, especially if the UAE builds additional plants.

UAE scores highly on virtually all infrastructure and financial criteria, and public opinion is highly favorable for nuclear energy development. The chief barrier to civil nuclear exports is the considerable strength of foreign competition.

Nuclear Infrastructure

Fuel: Canada-based Uranium One, UK-based Rio Tinto, France's Areva and Russia's Technobexport (Tenex) supply uranium concentrates to the UAE. Conversion services are to be carried out by Converdyn, Tenex and Areva. Enrichment will be done by Urenco, Areva and Tenex, and the fuel assemblies will be done by KEPCO.

Waste Management: The UAE is pursuing a national storage and disposal program as well as exploring regional cooperation options for radioactive waste management. The UAE has considered reprocessing used fuels internationally as an option, depending on the cost advantages. Responsibility of waste management and processing is planned to be assumed wholly by a state-owned entity within 20 years.



U.S. Government Collaboration

123 Agreement: The agreement entered into force December 17, 2009, and will expire December 17, 2039. The 123 Agreement requires that the UAE permanently forgo domestic enrichment and reprocessing capabilities, a commitment which was implemented as domestic legislation in 2009.

Barakah Plant Financing: The EXIM Bank approved \$2 billion in financing for the Barakah plant in September 2012 for U.S. sourced components from Westinghouse and services from it and two other firms. Most of it was for coolant pumps and controls.

U.S.-UAE Strategic Energy Dialogue: The SED was established in July 2014 to focus collaboration efforts in the number of energy areas to include civilian nuclear power.

Regulatory Cooperation: The U.S. NRC and the Federal Authority for Nuclear Regulation of the UAE (FANR) have an arrangement for the exchange of technical information and cooperation in nuclear safety and security matters. FANR has also signed agreements with the NRC to join the Code Applications and Maintenance Program (CAMP) and the Cooperative Severe Accident Research Program (CSARP).

International Engagement

The UAE is cooperating with numerous countries in its nuclear program development. It has signed cooperation agreements with the United States, Republic of Korea, UK, France, Canada, Russia,

Argentina, Japan, and Hungary. In November 2015, the UAE finalized a framework for cooperation with Australia to import fuel.

Additional Agreements	
Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	✓
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention Liability Agreement	
Vienna Convention Liability Agreement	✓
Joint Protocol Liability Agreement	✓
Convention on Supplementary Compensation for Nuclear Damage	✓
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	
OECD/NEA	
IFNEC	✓
GenIV International Forum (GIF)	
EURATOM	

Resources

For more information on the commercial opportunities in the United Arab Emirates, contact: Dao Le (Senior Commercial Officer, Abu Dhabi, dao.le@trade.gov), Gary Rand (Commercial Officer, Abu Dhabi, gary.rand@trade.gov); Nasir Abbasi (Principal Commercial Officer, Dubai, nasir.abbasi@trade.gov).

Emirates Nuclear Energy Corporation: <http://www.enec.gov.ae/>

Federal Authority for Nuclear Regulation: <https://fanr.gov.ae/en>

Sources

CIA Factbook, United Nations, World Nuclear Association, Asian Development Bank, the Economist, Embassy of the United Arab Emirates, and ITA contacts at the U.S. Embassy in Abu Dhabi and the U.S. Consulate in Dubai.

United Kingdom

Market Type: Existing and Expanding

Strong political support and plans for expansion mark the UK as a significant opportunity for U.S. civil nuclear exports, with good prospects for services for new plant construction, decommissioning, plutonium disposition, advanced reactor and SMR development. Robust foreign competition and financing are the chief obstacles for U.S. industry. Political uncertainty stemming from the UK's referendum to leave the EU could add additional challenges.

Overall
Rank

#1

Chargé d'Affaires to the United Kingdom: Lewis Lukens

U.S. Minister Counselor for Commercial Affairs to the United Kingdom: John Simmons (London)

Market Overview

The UK has 15 operational nuclear reactors, comprising 10.0 GWe of capacity. Fourteen of the fifteen currently operating reactors are scheduled to be shut down by 2030. The UK is planning to build new nuclear reactors to replace its existing fleet and make up for diminishing reserves of oil and natural gas. Though no official targets have been set, UK government officials have called for 16 GWe of installed nuclear capacity by 2030. The government has stated that there would not be any restriction on foreign equity in reaching this goal. Most of the UK's Advanced Gas Reactors (AGR), owned by France's EDF Energy, are running at significantly less than original capacity, although reactor life extensions and upgrades are ongoing.

EDF has begun preliminary construction for two European Pressurized Reactors (EPRs) at Hinkley Point in Somerset. Startup for the first reactor at Hinkley Point C is expected in 2025. China's state-owned China General Nuclear (CGN) has a 33.5 percent stake of the Hinkley Point C project and 20 percent at the planned EDF controlled Sizewell site. In return, EDF has granted CGN a controlling stake in a third site at Bradwell, where it will build and operate the Chinese designed Hualong One reactor (the first Chinese designed and built nuclear reactor in the West). In January 2017, CGN submitted its design proposal to the UK's Office for Nuclear Regulation (ONR) to begin a Generic Design Assessment (GDA), which is expected to take 4-5 years to complete and is required before construction can begin.

To support the Hinkley Point C project, the UK government agreed to a deal with EDF in October 2013 that included a 35-year Contract for Difference with a guaranteed electricity "strike price" subsidy. In September 2015, the UK government announced a £2 billion loan guarantee to support the project. A Final Investment Decision (FID) for Hinkley Point C was announced in September 2016. Once completed, the plant will provide 7 percent of the UK's electricity needs.

The Hitachi-GE-controlled Horizon Nuclear Power consortium plans to build four Advanced Boiling Water Reactors (ABWR) reactors at two sites: Wylfa in northern Wales and Oldbury in Gloucestershire. Construction of the first unit at Wylfa is planned for 2019, with startup expected in 2025. The ABWR reactor is currently being reviewed by ONR, a process that is expected to be completed in December 2017. As of June 2017, negotiations on how to finance the project were ongoing.

The NuGeneration (NuGen) consortium, 100 percent owned by Toshiba as of June 2017, but formerly 40 percent owned by France's Engie, plans to build three AP1000 reactors at Moorside, just north of the Sellafield site in Cumbria. Toshiba's financial difficulties and Westinghouse Electric Company's (WEC) March 2017 bankruptcy filing led Engie to exercise its right to sell its 40 percent stake in the project to Toshiba for \$139 million in April 2017. Toshiba has announced its intention to sell its stake in NuGen, with Korea Electric Power Corporation (KEPCO) publically expressing interest in buying Toshiba's stake. In May 2017 the UK newspaper The Sunday Times reported that China's State Nuclear Power Technology Corporation (SNPTC) is considering buying a stake in NuGen as well. In May 2017, NuGen announced that it is undertaking a strategic review of its options to ensure a stable platform to deliver the project. Prior to these developments, the first unit was expected to become operational in 2024, but this timeline may be delayed depending on what reactor technology is selected for the project. WEC's AP1000 received its GDA by ONR in March 2017. Neither the Korean APR1400 nor the Chinese CAP1400 have a GDA.

The UK's Department for Business, Energy and Industrial Strategy (BEIS) is currently examining the feasibility of its policy for managing the UK's large civil plutonium (Pu) stockpile, which involves reuse as mixed oxide fuel (MOX) and would require procurement of a new MOX plant. In January 2014, following the conclusion of a two-year review of disposition options, including GE's PRISM reactor, Candu's EC6 heavy-water reactor and Areva's MOX solution, the NDA said it will conduct further technical studies and that it may seek a "multi-track" approach. Regardless of the chosen solution, the UK will need to dispose of some Pu in a repository or other long-term storage location because a portion of the various Pu grades it possesses is not suitable for use in any reactor.

Small modular reactors (SMRs) have been the subject of interest in the UK with the government's March 2016 publishing of the first phase of a competition to identify the best value SMR design for the country. In November 2015, the government announced a £250 million nuclear R&D program, with half that amount dedicated to the SMR competition. If the competition is successful, an SMR project could move forward in the next decade.

Planned Nuclear Energy Projects

Hinkley Point C and Sizewell C NPPs

Owner: EDF Energy: EdF majority-owned, 33.5 percent CGN, 66.5 percent EdF; French government owns 85 percent of EdF, and Chinese government owns all of CGN.

Reactor Type: EPR

Capacity: 3240 MWe (2 units) at each plant

Value of Project: £24.5 billion total (\$17.6 billion per plant)

Construction Period: First unit 2017-2025

Operation (tentative): Hinkley C-1 and C-2 are planned for 2025 and 2026, with Sizewell C-1 and C-2 undetermined as of yet.

Wylfa and Oldbury B NPPs

Owner: Horizon: Hitachi-GE-controlled, other investors TBD.

Reactor Type: ABWR

Capacity: 2760 MWe (2 units) at each plant

Value of Project: £13-15 billion per plant

Construction Period: First unit 2019-2025

Operation (tentative): First unit in 2025

Moorside NPP

Owner: NuGen: 100 percent Toshiba

Reactor Type: AP1000 or other technology

Capacity: 3400 MWe (3 units)

Value of Project: \$20-24 billion

Construction Period: First unit 2019-2024

Operation (tentative): First unit in 2024

Bradwell NPP

Owner: CGN: CGN majority-owned, 66.5 percent CGN, 33.5 percent EDF)

Reactor Type: Hualong One (UK version)

Capacity: 2100 MWe (2 units)

Value of Project: unknown

Construction Period: TBD

Operation (tentative): TBD

Opportunities

Services (front-and back-end): Potential for back-end services, decommissioning, plutonium disposition and environmental/waste management.

Legal and Consulting Services: Limited potential

Licensing Support: Limited potential

Design, Construction, and Operation: Opportunities exist in owning, operating and constructing new NPPs. U.S. industry heavily engaged in Wylfa, Oldbury and Moorside plants. Potential for advanced reactor development and SMR development.

Opportunities in other sub-sectors, such as decommissioning, also exist, although there have been recent tendering challenges. In March 2014, Fluor was part of a joint venture (JV) that won a 14-year, \$11 billion contract to decommission 10 Magnox power plants and two research facilities. In March 2017, the UK government was ordered to pay nearly £100m in a settlement with U.S. companies EnergySolutions and Bechtel for mishandling the way it awarded the contract. As a result, Fluor's JV contract will end in September 2019 instead of 2028 and the government has announced that it will start a new tendering process.

Plutonium disposition provides a unique opportunity for U.S. exports but, at this point, is dependent on government policy decisions regarding technology selection. The NDA's draft Strategy and Business Plan (2016 to 2019) earmarked spending of £3.2 billion in financial year 2016/17. The NDA budget accounts for 60 percent of BEIS funding and is ring-fenced from cuts.

Challenges and Barriers

The UK's extensive plans to build new nuclear reactors have attracted high levels of interest from France, Germany, Korea, Japan, China, Russia and the United States. Despite heavy competition, U.S. industry has many opportunities for civil nuclear exports to the UK.

Bipartisan government support has been consistently strong since it adopted a pro-nuclear energy policy in 2006, and public opinion of new nuclear has remained favorable as the UK's plans have become more firm. While political support is strong, finding equity to finance projects without a state-backed nuclear energy corporation has proven difficult. Recent regulatory reforms put in place by the UK have largely been viewed as successful, but the majority of work that has gone into the approval process for commercial reactors is ongoing, and at this time it's uncertain if these reforms are proven to support civil nuclear development.

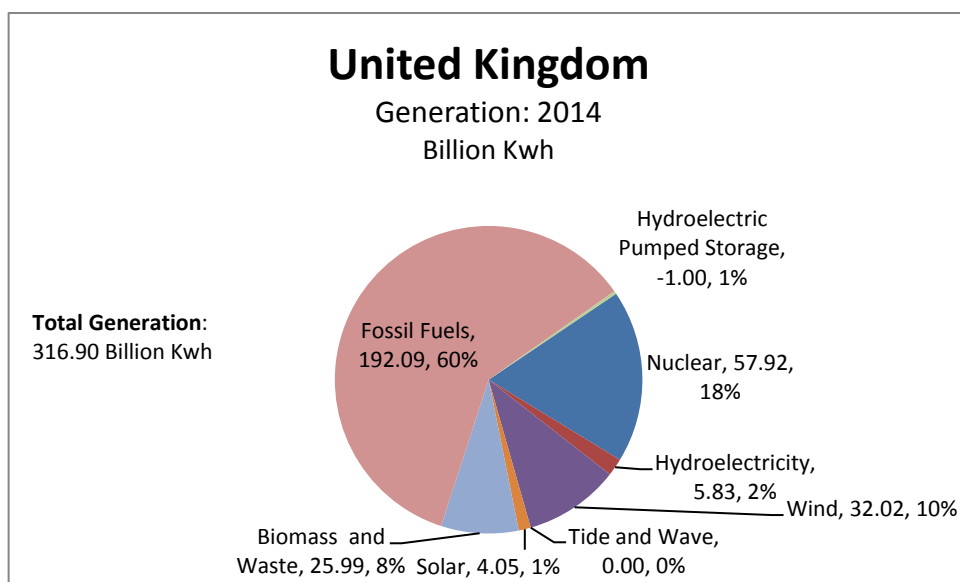
Political uncertainty stemming from the UK's referendum to leave the European Union and EURATOM could add additional challenges. The UK nuclear industry has issued public statements warning that a failure to put in place alternative arrangements to replace EURATOM would have a dramatic impact on the UK's planned new NPPs and cause major business disruptions across the nuclear fuel cycle. The UK's exit from EURATOM means that nuclear cooperation agreements would need to be put in place between the UK and the EU as well as with key nuclear countries outside the EU, including the United States, Japan, Australia and others.

Nuclear Infrastructure

Research Reactors: Only one research reactor, the Rolls Royce zero-power Neptune reactor in Derby, remains operational. Announced during the rollout of the Hinkley Point plant agreement, the UK and China resolved to cooperate on a £50 million Joint Research and Innovation Center, likely in Cumbria.

Fuel: Apart from raw uranium mining and uranium ore purification, the UK has an independent nuclear fuel cycle capability and offers services domestically and to international markets. The UK has several known small deposits of low-grade uranium, but none have been determined to be economically feasible to mine.

Waste Management: The Radioactive Waste Management Directorate (RWMD) is charged with developing plans for a Geological Disposal Facility (GDF) set to begin operation in 2040. Site selection is expected to take place by 2025.



U.S. Government Collaboration

123 Agreement: Nuclear cooperation between the United States and the United Kingdom falls under the framework of the U.S.-EURATOM 123 Agreement, which expires in 2026 with rolling five-year extensions from thereafter. The UK's decision to exit EURATOM means that the United States and the UK will need to renegotiate a bilateral U.S.-UK 123 Agreement.

Radioactive Waste Management: The U.S. Department of Energy's (DOE) Office of Environment Management and the British Nuclear Decommissioning Authority cooperate on radioactive waste management technology. This was initiated by a February 2012 Statement of Intent. In 2014, this Statement of Intent was amended to include the UK National Nuclear Laboratory Limited. DOE and DECC also signed an MOU in April 2012 for broader energy-related cooperation.

Regulatory Cooperation: The U.S. NRC and the Office of Nuclear Reactor of Great Britain (ONR) have an arrangement for the exchange of technical information and cooperation in nuclear safety and security

matters. ONR has also signed agreements with the NRC to join the Code Applications and Maintenance Program (CAMP) and the Cooperative Severe Accident Research Program (CSARP).

International Engagement

The UK continues to solicit international partners to achieve its civil nuclear plans. In 2013, the UK greenlit a deal between EDF and CGN for the 33.5 percent Chinese stake in the project at Hinkley Point, and in November 2015, it signed a Commercial Strategic Investment Agreement with China that will allow France's EDF and China's CGN to build NPPs at Hinkley Point and two other sites in the UK. In September 2013, the UK and Russia signed a nuclear cooperation agreement, and Russia has expressed interest in UK new build investments. More recently, Toshiba's financial challenges led Korea to express interest in purchasing Toshiba's stake in the NuGen project. The UK has welcomed international investment for decommissioning and operation of its current reactor fleet.

Additional Agreements	
Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	✓
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention Liability Agreement	✓
Vienna Convention Liability Agreement	
Joint Protocol Liability Agreement	✓
Convention on Supplementary Compensation for Nuclear Damage	
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	✓
OECD/NEA	✓
IFNEC	✓
GenIV International Forum (GIF)	✓
EURATOM	✓

Resources

For more information on the commercial opportunities in the United Kingdom, contact: Claudia Colombo (Commercial Specialist in London, Claudia.colombo@trade.gov); John Simmons (Minister Counselor for Commercial Affairs John.Simmons@trade.gov).

For more information on nuclear power in the United Kingdom, see: Nuclear Decommissioning Authority website (<https://www.gov.uk/government/organisations/nuclear-decommissioning-authority>), Office for Nuclear Regulation website (<http://www.onr.org.uk/>)

Sources

CIA Factbook, United Nations, World Nuclear Association, Asian Development Bank, and ITA contacts at U.S. Embassy London.

Vietnam

Market Type: Potential Market

To help satisfy booming electricity demand, Vietnam had been projected to be the first country in Southeast Asia with a civil nuclear energy program. Two proposed plants in Ninh Thuan province were to be built by Russia and a Japanese-led consortium, and, before the November 2016 decision to indefinitely defer these projects, up to 10 reactors were planned for deployment by 2025. Vietnam's growing public debt played a significant contributing factor in its decision to indefinitely defer its civil nuclear plans.

Overall
Rank

#47

U.S. Ambassador to Vietnam: Ted Osius

U.S. Commerce Attaché to Vietnam: Stuart Schaag

Market Overview

Vietnam was the first country in Southeast Asia moving forward on developing a peaceful nuclear power program; however, in November 2016 the country indefinitely deferred its plans to construct two nuclear power plants (NPPs) in favor of gas and coal. In late 2009, the National Assembly had approved plans to construct Vietnam's first two nuclear power plants (NPPs) of 1000 MW each in coastal Ninh Thuan province by 2025. The Government of Vietnam (GVN) had awarded contracts to Russia's Atomstroyexport and a Japanese consortium to each build a two-reactor NPP. Russia had agreed to fully finance its plant, and Japan was likely to finance up to the Organization for Economic Co-operation and Development's (OECD) limit of 85 percent. Prior to canceling of the projects, Russia and Japan had a head-start over the United States in terms of reactor projects in Vietnam, primarily due to both countries' ability to provide government-backed finance and other incentives.

The GVN had planned to develop the Ninh Thuan 1 and 2 NPPs with a total of eight 1000 MWe reactors coming on line annually from 2020 to 2027. Vietnam had announced plans to build up to 13 NPPs with a total capacity of 16,000 MWe over the next two decades. These announcements had presented rapidly emerging opportunities for the U.S. civil nuclear industry, before the indefinite deferral of the proposed NPP projects.

Planned Nuclear Energy Projects

All NPP projects have been postponed indefinitely.

Opportunities

Services (front and back-end): None at this time.

Legal and Consulting Services: None at this time.

Design, Construction, and Operation: None at this time.

Waste Management: None at this time.

Challenges and Barriers

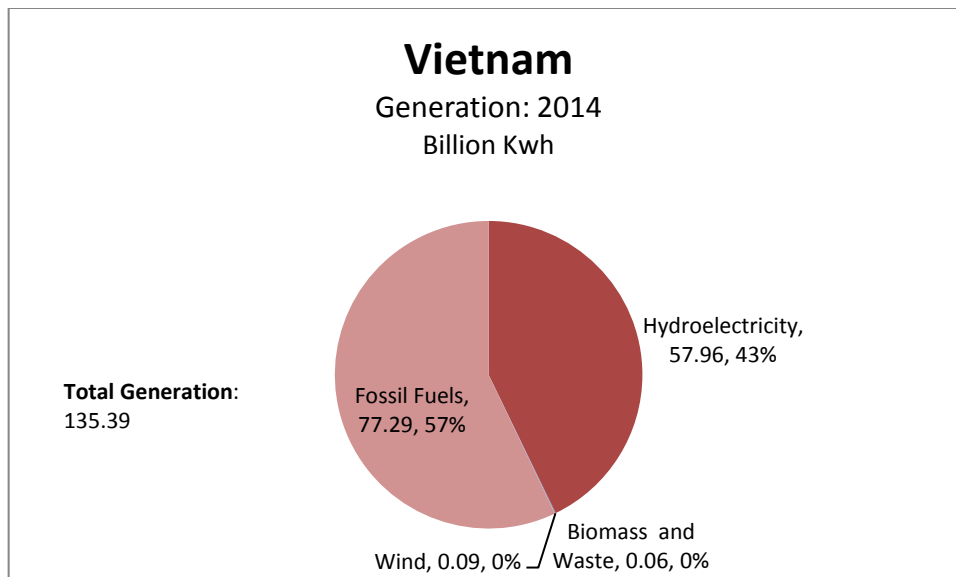
Vietnam's previous decision to contract with Russia and Japan for its first two reactor projects presented great challenges for U.S. industry to enter the market. The GVN had recently courted other countries, particularly the Republic of Korea, for bilateral civil nuclear cooperation. As the GVN is no longer following its nuclear development plans, there is little opportunity for U.S. industry exports.

Significant financial obstacles exist for civil nuclear exports to Vietnam. Russia and Japan won their construction contracts in part due to the significant financial incentives they offered, including financing deals. Vietnam scores low on both the EXIM Bank Long-Term Exposure Fee Level and the World Bank Ease of Doing Business Indicator, potentially hampering U.S. industry's ability to offer similar incentives. Additionally, U.S. industry's inability to offer build, own, operate construction or, as Russia has done, to take back and reprocess spent fuel may put U.S. industry at a disadvantage for future tenders.

Nuclear Infrastructure

Research Reactor: Vietnam has a 500 kW research reactor at Da Lat that has been operational since 1984. It is operated by Vinatom and was converted to run on low-enriched fuel in 2007 in partnership with the United States. It is due to be shut down around 2025. Despite Vietnam's deferral of plans for nuclear power, Russia's Rosatom still plans to adhere to their R&D commitments to establish the Center for Nuclear Energy Science & Technology (CNEST) under Vinatom, to be based in Hanoi, and is planned to include a new 15 MW research reactor.

Fuel: Vietnam's Ministry of Natural Resources & Environment is working with Canadian company NWT Uranium Corp to exploit a uranium deposit in Quang Nam province that is believed to have about 7000 tU in 0.05 percent ore.



U.S. Government Collaboration

123 Agreement: Agreement entered into force in October 2014 and will expire in October 2044 with rolling 5-year extensions.

Cooperation and Information Exchange: The National Nuclear Security Administration (NNSA) is involved in 11 programs affiliated with Vietnam and has engaged in workshops with Vietnam in a variety of topics including reactor licensing, nuclear forensics, and nuclear safeguards infrastructure development.

May 2013 Trade Mission: In May 2013, the then DOC Undersecretary for International Trade led a delegation of senior U.S. government officials from DOC, DOE, EXIM Bank and U.S. industry to work with the GVN on bilateral nuclear energy cooperation. DOC and FCS Vietnam organized a workshop in which U.S. firms shared their experience in nuclear power development with Vietnamese ministries and industry.

Regulatory Cooperation: The U.S. NRC and the Vietnam Agency for Radiation and Nuclear Safety of the Socialist Republic of Vietnam (VARANS) have an arrangement for the exchange of technical information and cooperation in nuclear safety and security matters. VARANS has also signed an agreement with the NRC to join the Code Applications and Maintenance Program (CAMP).

International Engagement

In recent years, Vietnam has signed nuclear cooperation agreements with Russia, France, China, South Korea, Japan, Canada and the United States. In addition to the reactor deals with Russia and Japan

detailed above, Vietnam has asked the Republic of Korea to conduct a feasibility study for a possible Korean NPP in Vietnam.

Additional Agreements	
Non-Proliferation Treaty	✓
IAEA Comprehensive Safeguards Agreement & Additional Protocol	✓
Joint Convention on Safety of Spent Fuel Management	
Convention on Nuclear Safety	✓
Convention on Early Notification of a Nuclear Accident	✓
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	✓
Paris Convention Liability Agreement	
Vienna Convention Liability Agreement	
Joint Protocol Liability Agreement	
Convention on Supplementary Compensation for Nuclear Damage	
Organization Membership	
IAEA	✓
Nuclear Suppliers Group	
OECD/NEA	
IFNEC	✓
GenIV International Forum (GIF)	
EURATOM	

Resources

For more information on the commercial opportunities in Vietnam, contact: Stuart Schaag (Senior Commercial Officer in Hanoi, stuart.schaag@trade.gov); Joshua Leibowitz (Acting Principal Commercial Officer in Ho Chi Minh City, Joshua.Leibowitz@trade.gov); Tuyet Trees (Commercial Specialist in Hanoi, tuyet.trees@trade.gov).

For more information on the nuclear energy industry in Vietnam, see:

Ministry of Industry and Trade website (<http://www.moit.gov.vn/en>)

Sources

CIA Factbook, United Nations, World Nuclear Association, Asian Development Bank, and officials at the U.S. Embassy in Hanoi.

Addendum: Resources for U.S. Exporters

The U.S. Government has numerous resources available to help U.S. exporters: from additional market research to guides to export financing, to overseas trade missions, to staff around the country and the world. A few key resources are highlighted below. For additional information about services from the International Trade Administration (ITA), please visit www.export.gov.

Country Commercial Guides

<http://export.gov/ccg/>

Written by U.S. Embassy trade experts worldwide, the *Country Commercial Guides* provide an excellent starting point for what you need to know about exporting and doing business in a foreign market. The reports include sections addressing market overview, challenges, opportunities and entry strategies; political environment; selling U.S. products and services; trade regulations, customs, and standards; and much more.

Basic Guide to Exporting

[Basic Guide to Exporting](#) *A Basic Guide to Exporting* addresses virtually every issue a company looking to export might face. Numerous sections, charts, lists and definitions throughout the book's 19 chapters provide in-depth information and solid advice about the key activities and issues relevant to any prospective exporter.

Trade Finance Guide: A Quick Reference for U.S. Exporters

<http://www.export.gov/tradefinanceguide/index.asp>

Trade Finance Guide: A Quick Reference for U.S. Exporters is designed to help U.S. companies, especially small and medium-sized enterprises, learn the basics of trade finance so that they can turn their export opportunities into actual sales and achieve the ultimate goal of getting paid—especially on time—for those sales. Concise, two-page chapters offer the basics of numerous financing techniques, from open accounts to forfeiting, to government assisted foreign-buyer financing.

Trade Missions <http://www.export.gov/trademissions/>

Department of Commerce trade missions overseas programs for U.S. firms that wish to explore and pursue export opportunities by meeting directly with potential clients in their markets.

Trade missions include among other activities: one-on-one meetings with foreign industry executives and government officials that are pre-screened to match specific business objectives.

Certified Trade Fairs

[http://www.export.gov/eac/show_short_trade_events.asp?CountryName=null&StateName=null&IndustryName=null&TypeName=International percent20Trade percent20Fair&StartDate=null&EndDate=null](http://www.export.gov/eac/show_short_trade_events.asp?CountryName=null&StateName=null&IndustryName=null&TypeName=International%20Trade%20Fair&StartDate=null&EndDate=null)

The Department of Commerce's trade fair certification program endorses overseas trade shows that are a reliable venue and a good market for U.S. firms to sell their products and services abroad. These shows serve as a vital access vehicle for U.S. firms to enter and expand into foreign markets. The certified

show/U.S. pavilion ensures a high-quality, multi-faceted opportunity for American companies to successfully market overseas. Among other benefits, certified trade fairs provide U.S. exhibitors with help facilitating contacts, market information, counseling and other services to enhance their marketing efforts.

International Buyer Program <http://export.gov/ibp/>

The International Buyer Program (IBP) brings thousands of international buyers to the United States for business-to-business matchmaking with U.S. firms exhibiting at major industry trade shows. Every year, the International Buyer Program results in millions of dollars in new business for U.S. companies by bringing pre-screened international buyers, representatives and distributors to selected shows. U.S. country and industry experts are on site at IBP shows to provide hands-on export counseling, market analysis and matchmaking services. Each IBP show also has an International Business Center where U.S. companies can meet privately with prospective international buyers, prospective sales representatives and business partners and obtain assistance from experienced ITA staff.

The Advocacy Center

<http://www.export.gov/advocacy/>

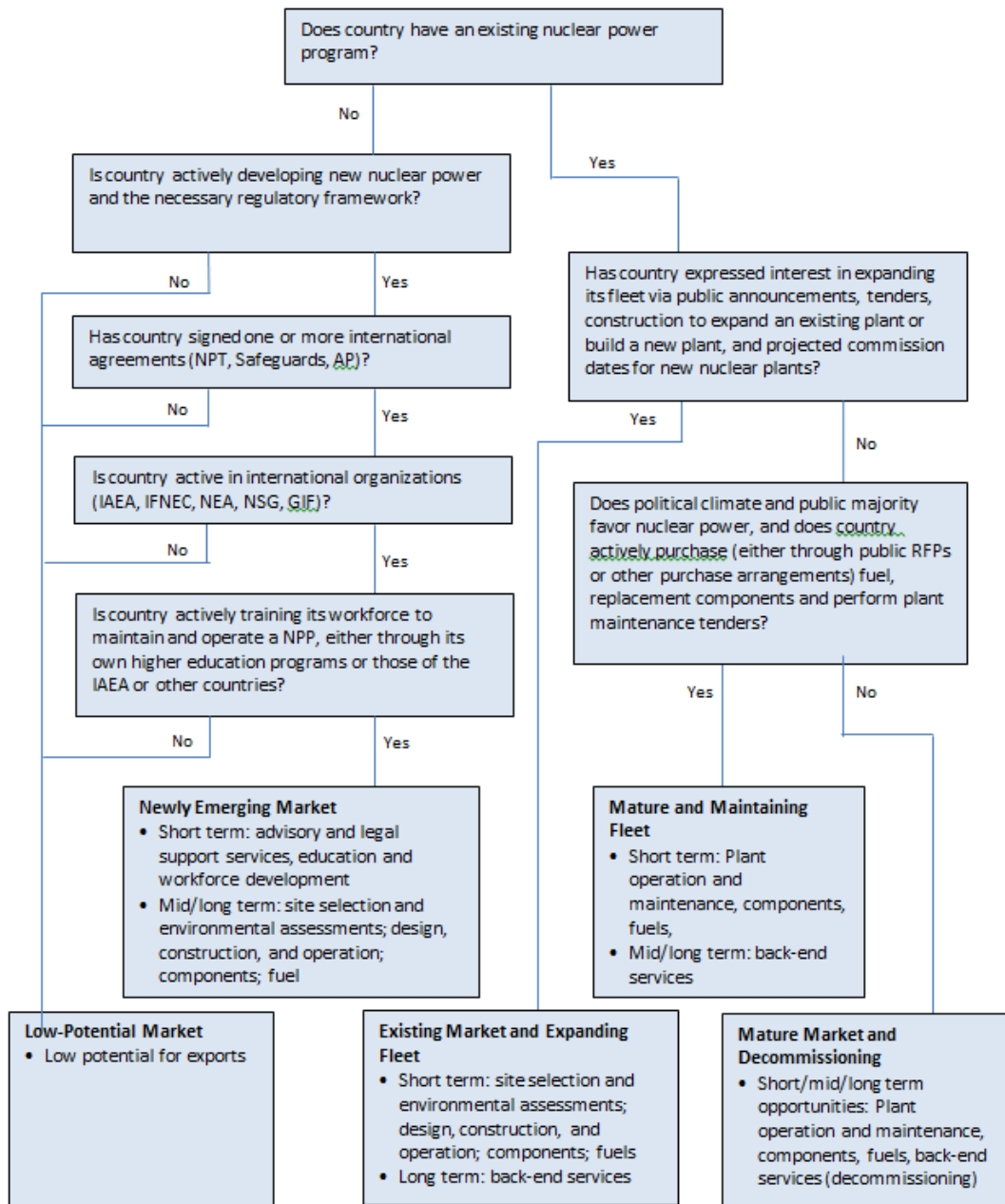
The Advocacy Center coordinates U.S. government interagency advocacy efforts on behalf of U.S. exporters bidding on public-sector contracts with overseas governments and government agencies. The Advocacy Center helps to ensure that sales of U.S. products and services have the best possible chance competing abroad. Advocacy assistance is wide and varied but often involves companies that want the U.S. government to communicate a message to foreign governments or government-owned corporations on behalf of their commercial interest, typically in a competitive bid contest.

U.S. Commercial Service

<http://www.export.gov/usoffices/index.asp>

With offices throughout the United States and in U.S. Embassies and Consulates in nearly 80 countries, the U.S. Commercial Service utilizes its global network of trade professionals to connect U.S. companies with international buyers worldwide. Whether looking to make their first export sale or expand to additional international markets, companies will find the expertise they need to tap into lucrative opportunities and increase their bottom line, including trade counseling, actionable market intelligence, business matchmaking and commercial diplomacy.

Appendix 1: Market Categorization Flow Chart



Appendix 2: Citations

ITA's 2017 Civil Nuclear Energy Top Markets Report ranks 50 countries in terms of their readiness for nuclear energy and openness to U.S. civil nuclear exports. Individual market ratings for exports related to new builds, existing reactors and decommissioning were assessed on the basis of 19 variables encompassing qualitative and quantitative measures.

Quantitative data were obtained from a variety of sources including the Energy Information Administration (EIA), Office of the U.S. Trade Representative (USTR), the World Nuclear Association (WNA), the World Bank, the International Atomic Energy Agency (IAEA), the International Energy Agency (IEA), the U.S. Census Bureau, and the U.S. International Trade Commission (ITC). Qualitative analysis was informed by company consultations, U.S. Commerce Department Civil Nuclear Trade Advisory Committee (CINTAC) input, unclassified USG cables, USG analyst expertise, and questionnaires distributed to ITA staff at U.S. Embassies and Consulates in countries that have indicated an interest in expanding or developing their nuclear energy programs.

The total score for a given market is computed by adding together three sub-sector scores—new builds, existing reactors, and decommissioning—that comprise the full spectrum of civil nuclear exports of goods and services. Each of these sub-sector scores are discussed below.

New Builds

The new build sub-score includes a variety of goods and services that accompany contracts for the construction of new nuclear reactors, including construction equipment, reactor components, fuel for initial core loads, site selection studies, safety training and human resource development services, and regulatory and licensing advisory services. Market opportunities for advanced reactors, such as small modular reactors (SMRs) and high-temperature gas-cooled reactors (HTGRs), are included in this sub-sector.

The new build sub-score is computed by the multiplication of the following factors (see Appendix for more information on methodology):

- Market Access: measures strength of bilateral relationship with U.S., foreign competition, and local content.
- Potential Market Size: score is weighted to measure the size of market opportunity.
- Government and Political Support for New Builds: measures strength of host-country government support.
- IAEA Milestones Factors: includes measurements for financial fitness, energy drivers, and accession to necessary international agreements.

Figure 38: Methodology Used to Rank Civil Nuclear Export Markets



Each of the four factors above is considered essential for new build export opportunities, such that a zero value for any single factor would negate the prospect of new build exports. This is why a multiplication formula was chosen. Thus, a market that is virtually closed to U.S. civil nuclear exports—such as Russia, due to a robust domestic industry and Russian government policy—or one with publically stated government opposition to new nuclear reactors—such as Germany—would receive scores of zero for new builds, regardless of how well it scores in other factors.

The new build score is given the most weight in computing the total score due to two main assumptions. First, the new build sub-sector is assumed to have the largest potential for exports, both in dollar value and number of contracts. This reflects the fact that a win for a U.S. reactor vendor often results in numerous additional contracts for U.S. goods and services, engages the U.S. civil nuclear supply chain, and can result in a long-term relationship with the market leading to future projects.

This assumption also recognizes that even in cases where a foreign reactor vendor is awarded a new build contract, export opportunities exist through sub-contracts or partnerships with foreign companies, thus adding to the potential value of U.S. exports in the new build sub-sector. Second, the study assumes that USG support is most needed in the new build sub-sector because the chief competition for reactor tenders comes from foreign state-backed companies that put U.S. industry at a competitive disadvantage. This is true for new build contracts more so than existing reactor or decommissioning contracts, which entail far lower financing barriers and often have the benefit of existing corporate relationships.

Existing Reactors

Exports related to existing reactor fleets include reactor components, fuel and a variety of services, such as safety training, human resource development and used fuel management. This sub-sector is assigned the second highest weight for computing the total score.

The sub-score for existing reactors is computed by multiplying two factors:

- **Market Access:** includes strength of bilateral relationship, foreign competition, local content requirements and an assessment of whether the current reactor fleet includes technology that is compatible with U.S. industry expertise.

- Size of Existing Reactor Program: export opportunities assumed to be directly related to the size of existing fleet.

Decommissioning

This sub-sector includes decommissioning and decontamination of goods and services and related advisory services. It is given the smallest weight of the three sub-sectors in computing the total market score, reflecting the current dollar value and number of opportunities for decommissioning exports. As reactor fleets age and more countries—whether for political, economic or technological reasons—decide to shut down plants, the size of this sub-sector will expand. In addition, recent events, such as the March 2011 Fukushima accident and subsequent decisions of several nations to shut down, reactors early or phase out their reactor fleets have brought about a renewed focus on decommissioning and decontamination export opportunities. This highlights the need for sustained, long-term USG support for export opportunities in this sub-sector.

The decommissioning sub-score is computed by the multiplication of two factors:

- *Market Access*: includes the strength of bilateral relationship, foreign competition and local content requirements.
- *Decommissioning Projects and Plans*: announced or active decommissioning projects.

Description of variables for new builds:

Market Access	Foreign Competition	Measures on a scale of high to low the strength of foreign competition for new builds. Assessment takes into account a country's political relationship with the United States and the likelihood of the market to favor U.S. companies.
	Localization	Measures on a scale of high to low the estimated quantity of localized content for a new build.
Market Size	Number of proposed new builds	Measures number of proposed new builds over the next 15 years.
Government and Political Support	Government Support for New Nuclear Power Plants	Qualitatively assesses strength of government support for building new reactors. Assessment includes factors such as public statements from government officials, program and policy consistency (or, conversely, history of policy changes and delays), interactions between industry and government staff with foreign officials, and political stability.
	Public Opinion	Measures favorability of public opinion toward nuclear power and new builds. Sources include opinion polls and survey results from U.S. Embassies, as available.
	Plans for New Nuclear Power Plants	Assesses official national policies for new builds according to time horizon and steps taken to implement plans. This variable is distinct from that of "government support" above, as this variable assesses official plans, whereas the "government support" variable attempts to measure the probability of a government following through on its plans. For example, a market scoring high in "government support," but whose national policy envisions beginning new construction more than ten years in the future, will score low in this category.
	Current Construction	Considers whether reactors are currently being built. Current reactor construction will boost a country's score since it attests to the market's ability and intention to build new reactors.

Infrastructure, Financial Factors, and Energy Drivers	Liability Framework	Assesses whether a nation adheres to a formal liability regime. Nations adhering to the CSC, 1997 Protocol to the Vienna Convention, or 2004 Protocol to the Paris Convention receive higher scores.
	123 Agreement	Assesses whether a 123 Agreement has been signed with United States or is under discussion.
	Projected Electricity Demand Growth	Assesses the scale of increasing demand for electricity over the next 15 years.
	Domestic Energy Availability	Assigns a score, from low to high, on whether a market is a net coal and/or natural gas exporter, a net total fossil fuel exporter, or a net energy importer. A net coal and/or natural gas exporter receives the lowest score because coal and natural gas are direct competitors with nuclear energy, while other fossil fuels compete less.
	U.S. EXIM Bank Long-Term Exposure Fee Level	OECD compliant, transaction specific risk premium charged by an ECA to finance projects and account for the risk that the transaction will not be repaid. http://www.exim.gov/tools-for-exporters/exposure-fees/long-term-exposure-fee-advice
	Ability to Self-Finance	Qualitative assessment of a market's ability to finance a new nuclear power plant without assistance from other countries.
	GDP	Rates each market according to GDP relative to other markets. Higher GDP receives a higher score.
	World Bank Ease of Doing Business Indicator	Rates each market according to rank in the World Bank Ease of Doing Business Indicator.

Description of variables for existing reactors:

Category	Variable	Description
Market Access	Foreign Competition	Measures on a scale of high to low the strength of foreign competition for existing reactor contracts. Assessment takes into account the technology composition of existing reactor fleet and gives a higher score for the presence of Western designs.
	Localization	Measures on a scale of high to low the estimated quantity of localized content for contracts relating to existing reactors.
Size of Existing Reactor Program	Reactor Fleet Size	Measures size of existing reactor fleet. Reactors currently under construction are included in this measurement because it is assumed they will become operational within the next 15 years and thus fall within the scope of this report.

Description of variables for decommissioning:

Category	Variable	Description
Market Access	Foreign Competition	Measures on a scale of high to low the strength of foreign competition for decommissioning contracts. Assessment takes into account the technology composition of existing reactor fleet and gives a higher score for the presence of Western designs.
	Localization	Measures on a scale of high to low the estimated quantity of localized content for contracts relating to decommissioning.
Decommissioning Plans	Decommissioning Plans	Measures the number of reactors that will need decommissioning services within ten years and opportunities for decontamination services.

Appendix 3: Top 50 Overall Markets for U.S. Civil Nuclear Exports

1. UK	23. Argentina	45. Nigeria
2. China	24. Finland	46. Kuwait
3. India	25. Germany	47. Vietnam
4. UAE	26. Taiwan	48. Niger
5. Japan	27. Bulgaria	49. Italy
6. Mexico	28. Kazakhstan	50. Russia
7. Czech Republic	29. Lithuania	
8. Poland	30. Malaysia	
9. Saudi Arabia	31. Jordan	
10. Turkey	32. Slovenia	
11. Canada	33. Indonesia	
12. France	34. Armenia	
13. ROK	35. Netherlands	
14. South Africa	36. Hungary	
15. Romania	37. Philippines	
16. Spain	38. Chile	
17. Slovakia	39. Bangladesh	
18. Ukraine	40. Egypt	
19. Switzerland	41. Ghana	
20. Brazil	42. Mongolia	
21. Belgium	43. Australia	
22. Sweden	44. Kenya	

Appendix 4: Subsector Definitions

The U.S. civil nuclear energy supply chain spans reactors, fuel services, nuclear engineering, procurement and construction, and advisory services to meet the needs of the global expansion of nuclear power. Below is further detail on each subsector's specialty.

Advisory and Legal Support Services

This subsector contains companies that provide advisory and consulting services that address the development of legal and regulatory regimes, licensing support, siting, environmental impact analyses, legal advice and tender writing and development. Standards development and trade association activities are also included within this subsector.

Design, Construction and Operation

Companies in this subsector are responsible for technology design and engineering, procurement, project management, site preparation, plant construction and plant operation and maintenance. This subsector addresses all activities in the engineering, procurement and construction (EPC) phase of a nuclear power plant project and also covers utilities that operate plants and companies that provide plant maintenance and repair.

Components

Companies in this subsector are generally manufacturers that seek commercial opportunities throughout a nuclear power plant's lifecycle, including parts required for operation and maintenance, uprates and upgrades. We delineate this subsector to reflect commercial opportunities for component manufacturers independent of Nuclear Steam Supply System (NSSS) providers.

Fuels

The fuels subsector includes all aspects of the nuclear fuel cycle, including mining and milling uranium, enrichment, conversion, fabrication of assemblies, refueling, transportation of fuel and fuel storage.

Back-End Services

Companies in this subsector provide services related to nuclear power plant decommissioning and used fuel management, including waste management and removal, remediation, used fuel management, interim storage and transportation, geologic disposal and reprocessing and recycling of plant byproducts.

Appendix 5: Role of U.S. Government Agencies in Civil Nuclear Energy

The U.S. government supports the expansion of safe and secure nuclear power worldwide through a variety of bilateral and multilateral mechanisms, including areas such as nuclear financing, nuclear trade promotion, safeguards and security of nuclear materials, research and development, and management of nuclear waste and storage. The descriptions below provide more detail on the responsibilities of each U.S. Government Program.

Export-Import Bank of the United States (EXIM Bank)

EXIM Bank is the official export credit agency of the United States. Its mission is to help create and maintain American jobs by supporting the export of U.S. goods and services to international markets. EXIM Bank provides working capital loan guarantees (pre-export financing), export credit insurance, and loan guarantees and direct loans (buyer financing).

EXIM Bank has provided financial support for numerous nuclear power plants in multiple countries. EXIM Bank can provide special extended repayment terms of up to 18 years to support the export of U.S. goods and services required for nuclear power plants. For all financing requests, EXIM Bank performs due diligence on the financial, legal, technical and environmental aspects of the proposed project. In addition, the technical, environmental and safety-related performance of all nuclear projects financed by EXIM Bank is monitored through the full term of EXIM Bank's financial support.

For more information visit www.exim.gov.

U.S. Department of Commerce

International Trade Administration (ITA)

ITA strengthens the competitiveness of U.S. industry, promotes trade and investment and ensures fair trade through the rigorous enforcement of trade laws and agreements. ITA works to improve the global business environment and helps U.S. organizations compete at home and abroad. Several ITA offices support the civil nuclear industry.

Industry and Analysis (I&A) Office of Energy and Environmental Industries (OEEI)

I&A's OEEI is dedicated to promoting trade, investment and commercial partnerships for the energy and environmental sectors. I&A works to expand trade and investment in these sectors by participating in trade negotiations, organizing trade capacity building programs and evaluating the impact of domestic and international economic and regulatory policies. OEEI's Civil Nuclear Energy Team works with other USG agencies to develop a public policy environment that advances and promotes civil nuclear engagement with our global trading partners. In October 2008, OEEI launched the Civil Nuclear Trade Initiative (CNTI) to increase the commercial benefits from civil nuclear cooperation with other countries. The CNTI coordinates USG civil nuclear activities through TeamUSA interagency mechanism and the Trade Promotion Coordinating Committee (TPCC), an interagency task force that ensures the coordination and development of a government-wide export promotion plan.

For more information, please visit www.trade.gov/mas/ian/nuclear/index.asp.

U.S. Commercial Service (CS)

Every year, the CS helps thousands of U.S. companies export goods and services worth billions of dollars to destinations around the world. Located in over 100 cities across the United States and in U.S. Embassies and Consulates in more than 70 countries, its global network of trade professionals is dedicated to opening doors for U.S. business. Whether U.S. companies are looking to make their first export sale or expand to additional international markets, the CS offers trade counseling, market intelligence, business matchmaking, trade promotion events and commercial diplomacy designed to help U.S. companies succeed internationally.

For more information regarding assistance and in-country contacts, please visit www.export.gov.

Advocacy Center

ITA's Advocacy Center coordinates USG resources to level the playing field on behalf of qualified U.S. nuclear business interests as they compete against foreign firms for specific international nuclear contracts or other U.S. nuclear export opportunities. Specifically, the Advocacy Center advocates on behalf of approved U.S. civil nuclear companies that are competing for nuclear power tenders abroad by garnering support from USG officials as they interact with foreign government decision makers.

For more information about ITA's Advocacy Center, please visit www.trade.gov/advocacy.

Bureau of Industry and Security (BIS)

The Bureau of Industry and Security (BIS) in the U.S. Department of Commerce is charged with the licensing, development, implementation and interpretation of U.S. export control policy for dual-use commodities, software and technology. See Appendix 5 (Key Trade Policy Issues in Civil Nuclear Energy, Export Controls) below for more information on BIS.

For more information on BIS, please visit www.bis.doc.gov.

U.S. Department of Energy (DOE)

Office of Nuclear Energy (NE)

NE advances nuclear power as a resource capable of meeting energy, environmental and national security needs by resolving technical, cost, safety, proliferation resistance and security barriers through research, development and demonstration (RD&D). NE conducts civil nuclear energy RD&D to support the safe and reliable operation of the current nuclear power reactor fleet, to develop advanced reactor designs and sustainable nuclear fuel cycles, and to minimize the risks of nuclear proliferation. In all these efforts, NE collaborates with other USG agencies, DOE's National Laboratories, U.S. industry and universities, and international partners. NE has a robust program of international engagement. Bilaterally, NE collaborates on RD&D through a variety of mechanisms, including action plans and

working groups, R&D agreements and the International Nuclear Energy Research Initiative. Multilaterally, NE cooperates with international partners through the International Atomic Energy Agency (IAEA), the Generation IV International Forum, the Nuclear Energy Agency of the Organization for Economic Cooperation and Development (OECD/NEA), and the International Framework for Nuclear Energy Cooperation. In addition, NE leads the development of international commercial back-end fuel services concepts.

For more information about NE, please visit www.energy.gov/ne/office-nuclear-energy.

NE/NNSA Comprehensive Engagement for Emerging Nuclear Energy Programs

NE is working closely with DOE's National Nuclear Security Administration (NNSA) on revising integrated engagement approach to support countries with expanding nuclear energy programs and emerging nuclear energy programs, to assist them in maintaining and developing the necessary nuclear infrastructure, safety, security, safeguards and emergency response capabilities. NE and NNSA seek to address these issues comprehensively as early as possible in the planning process for expansion of nuclear power programs and before the design and construction of new nuclear energy systems begin. To this end, NE and NNSA are compiling a list of necessary activities and have identified existing DOE training and technical assistance programs that can support a country's specific needs at various stages in the development of its nuclear energy program. NE and NNSA also closely coordinate to support the IAEA's efforts to assist member states in the development of safe and secure nuclear energy programs.

National Nuclear Security Administration (NNSA)

In addition to its cooperation with NE, NNSA, through its Office of Defense Nuclear Nonproliferation, works closely with a wide range of partners to detect, secure and dispose of dangerous nuclear and radiological material and related Weapons of Mass Destruction (WMD) technology and expertise. NNSA supports the safe and secure expansion of nuclear power providing technical assistance to the U.S. Department of State its negotiation of agreements for peaceful nuclear cooperation (123 Agreements), reviewing export applications for nuclear-specific and WMD-related dual-use equipment, and controlling the export of unclassified U.S. nuclear technology and assistance. NNSA also engages with the IAEA and other international partners to strengthen civil nuclear safeguards and security infrastructure.

NNSA is also responsible for the management and security of the nation's nuclear weapons and naval reactor programs and responds to nuclear and radiological emergencies in the United States and abroad. Additionally, NNSA federal agents provide safe and secure transportation of nuclear weapons and components and special nuclear materials along with other missions supporting national security.

For more information about NNSA's Office of Defense Nuclear Nonproliferation, please visit www.nnsa.energy.gov.

Office of Environmental Management (EM)

EM's mission is to complete the safe cleanup of the environmental legacy brought about from five decades of nuclear weapons development and government-sponsored nuclear energy research. EM's

capabilities include tank waste management, deactivation and decommissioning, nuclear material disposition, and soil and groundwater remediation. EM invests in research and technology development in all of these areas to improve the efficiency and cost-effectiveness of addressing unprecedented environmental challenges. It also collaborates closely with international and U.S. partners in industry, government, academia and national laboratories to share technical knowledge and best practices for meeting regulatory and site cleanup requirements while protecting human and ecological health.

For more information on EM, please visit www.energy.gov/em/office-environmental-management.

U.S. Department of State

Bureau of International Security and Nonproliferation/Office of Nuclear Energy, Safety and Security (ISN/NESS)

ISN/NESS develops U.S. policy relating to peaceful nuclear cooperation, nuclear safety, nuclear export controls and the physical protection of nuclear materials and facilities, in furtherance of U.S. nuclear nonproliferation goals concentrating on technical aspects of nuclear technology and the dangers of nuclear proliferation. It works bilaterally, negotiating 123 Agreements and implementing nuclear cooperation programs, and multilaterally, interacting with the IAEA, the OECD/NEA and the Nuclear Suppliers Group. ISN/NESS also coordinates interagency efforts to implement the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management and to encourage additional countries to join the Convention on Supplementary Compensation for Nuclear Damage and the Convention on the Physical Protection of Nuclear Material and Nuclear Facilities.

For more information about the ISN/NESS, please visit www.state.gov/t/isn.

Bureau of Energy Resources (ENR)

ENR ensures that U.S. diplomatic relationships advance U.S. interests in having access to secure, reliable, and ever-cleaner sources of energy. The ENR focus is to manage the geopolitics of today's energy economy through diplomacy; to enable global energy transformation through energy policy that stimulates market forces for alternative energy, clean electricity, development and reconstruction; and to expand good governance, increase transparency and improve commercially viable and environmentally sustainable access for the 1.3 billion people without access to electricity and the 2.7 billion people without access to modern energy services.

For more information on ENR, please visit www.state.gov/e/enr.

U.S. Nuclear Regulatory Commission (NRC)

The U.S. Nuclear Regulatory Commission (NRC) is an independent agency charged with oversight of U.S. commercial nuclear activities in order to protect the public health and safety, promote the common defense and security, and protect the environment.

NRC executes this important duty by licensing and regulating the nation's civilian use of byproduct source and special nuclear materials. NRC's regulations are designed to protect both the public and workers against radiation hazards from industries that use radioactive materials.

NRC's scope of responsibility includes regulation of commercial nuclear power plants; research, test and training reactors; nuclear fuel cycle facilities; medical, academic and industrial uses of radioactive materials; and the transport, storage and disposal of radioactive materials and wastes. In addition, NRC licenses the import and export of radioactive materials and works to enhance nuclear safety, safeguards and security throughout the world.

NRC adheres to the principles of good regulation—independence, openness, efficiency, clarity and reliability. The agency puts these principles into practice with effective, realistic and timely regulatory actions, consistent with our organizational values and our open, collaborative work environment.

NRC supports U.S. interests abroad in the safe and secure use of nuclear materials and in guarding against the spread of nuclear weapons. NRC actively participates in international working groups and provides advice and assistance to international organizations and foreign countries to develop effective regulatory organizations and enforce rigorous safety standards.

NRC has bilateral programs of assistance or cooperation with 43 countries, Taiwan and the European Atomic Energy Community. NRC's international exchange programs provide joint cooperative activities and assistance to other countries to develop and improve regulatory organizations. Two of these programs are the International Regulatory Development Partnership (www.irdp-online.org) and the Radiation Sources Regulatory Partnership (www.rsrp-online.org).

NRC's information exchange arrangements with foreign regulatory authorities establish the framework for NRC to gain access to non-U.S. safety information that can (1) alert the United States of potential safety problems, (2) help identify possible accident precursors, and (3) provide accident and incident analyses, including lessons learned, that could be directly applicable to the safety of U.S. nuclear power plants and other facilities. They also serve as vehicles for the health and safety assistance that NRC supplies to emerging countries in their efforts to develop and enhance their regulatory capabilities and their nuclear safety infrastructure. Thus, the arrangements facilitate NRC's strategic goal to support U.S. interests in the safe and secure use of nuclear materials and in nuclear nonproliferation both at home and abroad.

For more information, please visit the NRC's website at www.nrc.gov.

Appendix 6: Key Trade Policy Issues in Civil Nuclear Energy

U.S. Department of Commerce Civil Nuclear Trade Initiative:

In December 2008, the Department of Commerce launched the Civil Nuclear Trade Initiative (CNTI) to strengthen the competitiveness of the U.S. nuclear industry as it endeavors to rebuild its manufacturing base by capturing opportunities abroad. The Initiative, developed and administered by the Industry & Analysis (I&A) unit within the International Trade Administration, identifies the industry's most pressing trade challenges and most promising commercial opportunities and coordinates public and private sector efforts to address these issues. The Initiative aims to demonstrate and provide strong USG support for the U.S. civil nuclear industry to create an environment where U.S. companies can compete successfully and on a level global playing field, particularly against the state-owned competition.

The Initiative involves four areas of work:

- 1) The Trade Promotion Coordinating Committee's (TPCC) Civil Nuclear Trade Working Group - an interagency working group that coordinates USG policy and activities affecting U.S. civil nuclear trade
- 2) Commerce's Civil Nuclear Trade Advisory Committee (CINTAC)
- 3) Trade policy and promotion activities, including, among others, a U.S. Industry Program at the annual International Atomic Energy Agency (IAEA) General Conference, trade missions to best prospect markets, nuclear standards workshops and bilateral declarations on commercial nuclear cooperation
- 4) Stakeholder resources, including a civil nuclear trade web portal ([trade.gov/civil nuclear](http://trade.gov/civil-nuclear)), an on-line nuclear export controls guide, a small modular reactor commercial outlook report and other promotional materials

Liability - Convention on Supplementary Compensation for Nuclear Damage (CSC):

One of the biggest impediments to nuclear suppliers' pursuit of global opportunities is concern about potential legal liability in the event of a nuclear accident. Nuclear suppliers are reluctant or unwilling to participate in nuclear projects in countries where liability for a nuclear accident is NOT channeled exclusively to the operator of a nuclear facility or in countries where the operator may exercise a right of recourse against suppliers. U.S. nuclear suppliers also are concerned that, in the event of an accident outside the U.S., suppliers, as well as the operator, could be sued in U.S. courts that would apply normal tort law. In all these cases, suppliers would be subject to unlimited liability for which insurance is not available.

The best way to address the concern about potential liability is the establishment of a global nuclear liability regime based on well-recognized nuclear liability principles, including channeling all liability exclusively to the operator and granting exclusive jurisdiction over claims arising from a nuclear accident to the courts of the country where the accident occurs. The CSC is designed to be the basis for a global nuclear liability regime. Specifically, the CSC requires parties to have national law consistent with these principles either through being a party to one of the pre-existing international nuclear liability treaties (the Paris Convention or the Vienna Convention) or adoption of national law consistent with the

provisions of the Annex to the CSC. Parties to the CSC also must agree to contribute, in the event of a nuclear accident, to an international fund to compensate victims of nuclear damage. Countries with and without nuclear power facilities can become parties to the CSC.

With the ratification of the CSC by Japan in January 2015, the CSC entered into force in April 2015. India ratified the CSC in February 2016 and Canada ratified it in June 2017. The U.S. government is working to encourage more countries to ratify the CSC.

Peaceful Uses of Nuclear Energy Cooperation Agreements—123 Agreements

Section 123 of the U.S. Atomic Energy Act requires the conclusion of a peaceful nuclear cooperation agreement for significant transfers of nuclear material, equipment, or components from the United States to another nation. Moreover, such agreements, commonly referred to as “123 Agreements,” facilitate cooperation in other areas, such as technical exchanges, scientific research, and safeguards discussions. In conjunction with other nonproliferation tools, particularly the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), 123 Agreements help to advance U.S. nonproliferation principles. They establish the legal framework for significant nuclear cooperation with other countries. In order for a country to enter into a 123 Agreement with the United States, that country must commit to U.S.-mandated nuclear nonproliferation norms. The U.S. State Department is responsible for negotiating 123 Agreements, with the technical assistance and concurrence of DOE/NNSA and consultation with the U.S. Nuclear Regulatory Commission. As of January 20, 2017, the United States has entered into 23 such agreements that govern peaceful nuclear cooperation with 48 countries, the International Atomic Energy Agency and the governing authorities on Taiwan.¹

For more information on the list of 123 Agreements, please visit DOE/NNSA’s website at <http://go.usa.gov/DxjR>.

Export Controls

Part 810 Licenses

10 CFR Part 810 implements section 57 b. of the AEA, which controls the export of unclassified nuclear technology and assistance. Specifically, section 57 b. of the AEA prohibits any U.S. person from directly or indirectly engaging in the production of any special nuclear material outside of the United States except in cases where the U.S. Secretary of Energy has made a determination that the transfer is not inimical to the interests of the United States. These regulations enable peaceful nuclear trade by ensuring that nuclear technologies and assistance exported from the United States will be used for peaceful purposes.

¹ Pursuant to Sections 4 and 6 of the Taiwan Relations Act, P.L. 96-8, 93 Stat. 14, and Executive Order 13014, 61 F.R. 42963, agreements relative to Taiwan shall be entered into, performed, and enforced, in the manner and to the extent directed by the President, by or through the American Institute in Taiwan.

Part 810 licenses are issued pending the official concurrence of the U.S. Department of State and in consultation with the U.S. Department of Commerce, the U.S. Department of Defense and the NRC. Countries that would receive the technology transfer may be asked to provide government-to-government assurances that the technology provided will be used solely for civil nuclear activities and not for any nuclear explosive device, or other military purpose, and not retransferred from the territory of that state without prior U.S. consent. Such assurances confirm that the recipient government is aware of the transfer and guarantees that the technology will be used for peaceful purposes. The assurances usually take the form of a diplomatic note through the U.S. Embassy in the country to the Department of State, which then provides the assurances and formal concurrence in the transfer to the U.S. Secretary of Energy.

e810 Electronic Database: In May 2017, the NNSA published a Federal Register Notice to notify the public that “e810,” an electronic database for processing applications, reporting, and requests for determination for nuclear technology exports, is available for use. The e810 database is designed to ease the application and reporting burden on U.S. industry, streamline the review process for specific authorization applications and provide greater transparency into the authorization process and timelines. Companies are encouraged to register for accounts and to utilize the system to manage Part 810 communications. For more information about the e810 Electronic Database, please visit <https://e810.energy.gov/>

For more information, please visit DOE/NNSA’s website at <http://go.usa.gov/DxDm>.

Part 110 Licenses

The NRC has the responsibility and authority under the AEA to regulate the export and import of nuclear equipment and materials. These regulations are codified in 10 CFR Part 110 and apply to all individuals in the United States who export and import nuclear equipment, material or components subject to NRC licensing authority. Unless the export or import transaction falls under an exemption by the NRC, it must be authorized by an appropriate NRC license. NRC issues two types of export and import licenses, general and specific.

For more information, visit the NRC website at <http://go.usa.gov/DxDJ>.

Dual-Use Civil Nuclear Licensing

The Bureau of Industry and Security (BIS) in the U.S. Department of Commerce is charged with the licensing, development, implementation and interpretation of U.S. export control policy for dual-use commodities, software and technology. Dual-use items subject to BIS regulatory jurisdiction have predominantly commercial uses but may also have military, nuclear, missile, chemical, biological and weapons applications. The statutory authority for Commerce to regulate dual-use exports is the Export Administration Act of 1979 and is implemented through the Export Administration Regulations.

For more information, visit the BIS website at <http://go.usa.gov/DY5A>.

Industry & Analysis' (I&A) staff of industry, trade and economic analysts devise and implement international trade, investment, and export promotion strategies that strengthen the global competitiveness of U.S. industries. These initiatives unlock export and investment opportunities for U.S. businesses by combining in-depth quantitative and qualitative analysis with ITA's industry relationships.

For more information, visit
www.trade.gov/industry

I&A is part of the International Trade Administration (ITA), whose mission is to create prosperity by strengthening the competitiveness of U.S. industry, promoting trade and investment, and ensuring fair trade and compliance with trade laws and agreements.



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