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Fabrication Market Outlook

1501 MACY DRIVE ROSWELL, GA 30076
PH +1 770 642-7745 FX +1 770 643-2954

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Introduction and Overview

The Ux Consulting Company, LLC (UxC) is pleased to present the 2018 *Fabrication Market Outlook* (FMO) report, which is the 12th annual edition in this series. This year's report builds upon the significant enhancements made in previous editions as part of our ongoing effort to improve information exchange and understanding in the all-important global nuclear fuel fabrication marketplace. This edition also continues numerous improvements made to the structure and format of the FMO report in the 2017 edition.

The global nuclear industry is dealing with many headwinds these days, including the continuing aftereffects of the devastating Fukushima accident of 2011, the dramatic rise of competing energy forms (e.g., natural gas and renewables), as well as numerous negative policy initiatives in key countries around the world.

Beyond the well-known nuclear phase-out policies in places like Germany, Belgium, and Taiwan, there are also questions about the long-term operations of nuclear power plants in some of the dominant markets of the world. Concerns about premature reactor closures and new reactor cancelations are high in the U.S., which still maintains the world's largest nuclear fleet. New energy policies in key markets like France and South Korea are likely to reduce reliance on nuclear power. While France has already had such a policy in place for a while, the changing nature of South Korea's nuclear policy has taken many in the industry by surprise.

On the positive side, China continues to move forward with its nuclear expansion albeit at a much slower pace than before Fukushima. There are also still many new reactors under construction around the world, including in the United Arab Emirates, India, Russia, and elsewhere. The UK government has also agreed to proceed with the construction of two new reactors at Hinkley Point C. Meanwhile, with nine reactors approved for restart in Japan and several more in the pipeline, the story out of Japan is much more optimistic than it has been in past years. Still, it remains unclear if more than half of Japan's pre-Fukushima fleet will ever return to service.

Demand for nuclear fuel remains low, and the forecasts for its growth have also diminished. Nevertheless, the world will clearly still need substantial amounts of nuclear fuel fabrication, and the industry will need to respond to the various competing trends on the demand side.

On the supply side, there have been some monumental events affecting the future outlooks for key fabrication vendors. The French conglomerate AREVA has been split into two companies, with the fuel fabrication division joining the reactor construction and services divisions in the new Framatome. It remains too early to tell what the effects of this restructuring will be for Framatome's fuel fabrication business, but the market is keenly attuned to the recent major changes in France's nuclear industry.

Another huge development in the past year is Westinghouse's bankruptcy and sale by Toshiba to Brookfield Business Partners (a private equity group based in Canada). Following the financial losses emanating from the U.S. AP1000 projects in South Carolina and Georgia, and the cancelation of the South Carolina project, the new Westinghouse is shifting away from the reactor construction business. The new ownership under Brookfield has just begun, so many uncertainties still remain, but the good news for the fabrication division is that it remains one of the more profitable parts of Westinghouse's business and should remain this way for the future.

Russian vendor TVEL, which is still the dominant VVER fuel supplier despite inroads by Westinghouse in Ukraine, has also been making major strides in its efforts to enter the western PWR reload market. Following its first contract to supply a portion of the fuel for Vattenfall's Ringhals 3 reactor in Sweden, TVEL is now advancing its strategic alliance with Global Nuclear Fuel-Americas (GNF-A) with a first potential customer in Exelon, which will load Lead Test Assemblies starting in 2019.

These collective international issues, coupled with various other developments in the nuclear industry, in general, and the fuel fabrication industry, in particular, have suggested that there could be changes in worldwide fabrication markets. The interactions between buyers and sellers in the years ahead and our assessment of such changes are addressed throughout this FMO report, where appropriate.

As with previous editions, the primary focus of this FMO report is fuel fabrication for large light water reactors (LWRs) – boiling water reactors (BWRs) and pressurized water reactors (PWRs) – since these comprise the great majority of the nuclear plants currently in operation around the world and those planned for the future. The Russian VVER reactors installed in Russia, Eastern Europe, and other countries are, in fact, PWRs.

There are also several pressurized heavy water reactors (PHWRs) operating in Canada and other nations, advanced gas-cooled reactors (AGRs) in the United Kingdom, and several light water-cooled, graphite-moderated reactors (LGRs) in Russia (RBMK and EGP reactors). However, these regions/reactors represent unique fuel fabrication markets, which are covered at the end of this report.

In the chapters that follow, we address many of the diverse commercial, institutional, economic, and technical aspects of nuclear fuel, fuel fabrication, and the international fuel fabrication market. The report is intended to serve a variety of purposes:

- For those with little knowledge of nuclear fuel fabrication and its markets, the FMO serves as a primer, providing a solid background in various aspects of the industry and an understanding of how its markets function.
- For those knowledgeable in the fundamentals of fabrication, the FMO offers analyses of a variety of its aspects based on several decades of participation in the fabrication industry.

- And, for those who are actively involved in the industry as buyers or sellers of nuclear fuel assemblies, the FMO supplies additional up-to-date insights to assist in the improvement of existing nuclear fuel programs and in the development of new fabrication-related initiatives.

What's New in the 2018 Report?

In the 2018 *Fabrication Market Outlook* (FMO), we have updated all sections of the report and also continued with the new organization and format of the report begun last year. This includes our new *FMO Reference Document*, which incorporates portions of the previous FMO reports that are considered reference materials and do not change from year to year very much.

This year's FMO presents market data and analysis consistent with the style of UxC's other *Market Outlook* reports, and all the discussions and analyses have been updated to reflect the events of the past year. As part of the lead-up to this report, we have once again conducted a survey of international utility attitudes toward the fabrication market.

This year's essay, titled "Realignments in the Global Fabrication Industry," reviews the major changes affecting the various vendors and how these are likely to shape the future of the industry. Corporate restructurings, consolidation, and reorganizations are occurring with significant implications for suppliers and buyers alike.

Once again, we have classified the world's fabricators into three categories: the Mega-Vendors, large international suppliers to multiple markets; Emerging International Suppliers, those companies who are poised to expand beyond their current regional markets to directly challenge the Mega-Vendors in their principal markets; and the smaller regional and national suppliers. Analysis of each vendor's current situation and potential future developments in terms of market access and technical developments are presented in detail.

This year's fuel fabrication demand projection is drawn from our proprietary *UxC Requirements Model* (URM), which, starting with UxC's own internal forecasts for nuclear power capacities, calculates demand on a reactor-by-reactor, cycle-by-cycle basis. We continue to refine and improve our reactor forecasts and the URM and believe the current version produces more accurate forecasts than in prior years. UxC's nuclear growth forecasts are updated quarterly, and the fabrication demand projections used in this report reflect our very latest analyses in this regard.

Notably, in this 2018 edition, we have extended our forecasts by an extra five years to 2035 for all aspects of the report. This includes extended forecasts for reactor fuel demand, supply, as well as future LWR fuel prices.

The focus of the report are analyses of the current and future markets for fuel for LWRs, i.e., BWRs and PWRs; however, we also include an updated and expanded discussion of the fabrication markets for non-LWR fuel (e.g., PHWRs, AGRs, and

LGRs). Special efforts have been made to enhance our analysis of the PHWR fuel fabrication market, which represents about 11% of the world's reactors today. In addition, we have once again included a brief review of the potential fuel fabrication market for small modular reactors (SMRs) and other advanced reactors, although the future of SMRs and other advanced reactor designs remains in flux at this time.

Finally, as part of our continuing efforts to improve and enhance the analysis of the fuel fabrication markets, UxC made efforts to engage with global fuel fabricators, as well as their customers, to obtain the most accurate and up-to-date information possible. For this year's Utility Fabrication Market Survey, we received many excellent responses from utilities around the world.

- **FMO Reference Document**

  As a major change to our previous FMO reports, we have also decided to split the FMO report into two documents. The first is this main FMO report, which includes all of the chapters described in the following **Structure of Report** section. Second, in order to make the FMO more user-friendly and to reduce the total volume of the main report, we have extracted sections of the previous FMO that have remained relatively constant over the years and put them into a separate *FMO Reference Document*. This reference document is available to all FMO subscribers and can be accessed as a PDF file downloadable from the UxC Client Site (note that subscriber login credentials are required).[1] The *FMO Reference Document* includes the following sections:

  - Nuclear Fuel Fabrication Market Primer
  - History of the Nuclear Fuel Fabrication Industry
  - Utility Procurement Approaches and Contracting Issues
  - Typical Fuel Fabrication Service Contracts
  - Fuel Assembly Design, Manufacture & Performance

Structure of Report

This year's edition of the FMO continues our efforts to create a user-friendly text with each chapter containing clear and distinct information. The reader is encouraged to begin at **Chapter 1**, as there is intended to be a continuous and logical flow to the report; however, each individual chapter provides unique topical coverage that can also be considered independently from the rest of the report's contents. The report is structured as follows:

This year's in-depth topical essay in **Chapter 1 – Essay: Realignments in the Global Fabrication Industry** looks in detail at all the major developments in the

[1] Access to the FMO subscriber website is at: https://www.uxc.com/c/MktRptEssays.aspx?rpt=fmo

past year that have affected the fuel fabrication vendors and analyzes how these will affect the structure and nature of the industry in the future.

Chapter 2 – Reactor Developments and Demand Outlook begins our review of the fabrication market fundamentals with a look at current and future demand. This chapter presents UxC forecasts for nuclear power growth through 2035 from our *Nuclear Power Outlook* (NPO) and the resulting fabrication demand projection through 2035 using our *UxC Requirements Model* (URM).

Chapter 3 – Results from UxC Utility Fabrication Market Survey presents the results of our latest utility market survey and analyzes the latest trends in utility views on the fabrication market.

The supply side of the equation is addressed in **Chapter 4 – The World's Nuclear Fuel Fabricators**. This chapter includes in-depth profiles of each of the world's LWR fuel suppliers, their production facilities, their products, the markets they serve, and additional items of interest.

Chapter 5 – Supply and Demand Analysis combines all of the preceding discussions with a comparison of supply and demand for LWR fuel through 2035 on a global level as well as in each of the principal geographic market segments.

Since the market for fabricated LWR fuel is segmented both geographically and technically, each of these individual market segments is discussed and analyzed in **Chapter 6 – Global and Regional Market Analysis**.

Chapter 7 – Nuclear Fuel Fabrication Prices discusses the factors affecting current and future LWR fuel prices and presents UxC's latest projections for both PWR and BWR fuel fabrication prices in different regional markets through 2035.

Finally, in **Chapter 8 – Non-LWR Fuel Fabrication Markets**, we present a discussion of the unique fuel fabrication markets for pressurized heavy water reactors (PHWRs), gas cooled reactors (GCRs), and light water cooled, graphite-moderated reactors (LGRs). Small Modular Reactor (SMR) and advanced reactor fuel developments are also addressed at the end of this chapter.

The report also contains a series of appendices and a glossary, which provide background information and other useful items on the fabrication market. The following are found at the end of this report:

Appendix A – UxC 2018 Fuel Fabrication Market Survey Sample

Appendix B – Fuel Fabricator Contact Information

Glossary