



Fabrication Market Outlook



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Table of Contents

Executive Summary	i
<i>Essay: Realignments in the Fabrication Industry</i>	i
<i>Reactor Developments and LWR Fuel Demand Forecasts</i>	i
<i>UxC Utility Fabrication Market Survey</i>	ii
<i>The World's LWR Nuclear Fuel Fabricators</i>	ii
<i>Supply and Demand in the Nuclear Fuel Fabrication Industry</i>	iii
<i>LWR Nuclear Fuel Fabrication Markets</i>	iii
<i>LWR Nuclear Fuel Fabrication Prices</i>	iv
<i>Non-LWR Fuel Fabrication Markets</i>	iv
Introduction and Overview	9
What's New in the 2018 Report?	11
• FMO Reference Document	12
Structure of Report	12
1 – Essay: Realignments in the Global Fabrication Industry	14
Mega-Vendor Upheaval	15
• AREVA NP Becomes Framatome under EDF Majority Ownership	15
Future Outlook	16
• Westinghouse Purchased by Brookfield Partners	17
Future Outlook	18
• GNF-A Cutting Costs and Teaming with TVEL	20
Future Outlook	20
Major Shifts for Regional Fabricators	21
• TVEL on the Defensive and Offensive	21
Future Outlook	22
• South Korea's Anti-nuclear Government Hurting KNF's Future	23
Future Outlook	24
• Japanese Fabrication Industry Consolidation	24
Future Outlook	25
• China's Fabrication Industry Reorganizes and Prepares for Growth	25
Future Outlook	26
Industry Perceptions and Implications for the Future	27
• Results from UxC Survey Questions	27
Framatome as a Long-Term Supplier Following Reorganization	27
Westinghouse as a Long-Term Supplier Following Reorganization	27
Geopolitical Factors Affecting TVEL as a PWR Fuel Supplier	28
Future of Japan's Fabrication Industry	28
China as a Future Global Supplier	29
• Conclusions	29
2 – Reactor Developments and Demand Outlook	30
UxC Nuclear Power Regions	31
Reactor Capacities Anticipated by Country by 2035	32
Alternative UxC Reactor Forecast Cases	35
Current and Future Reactor Types	36
• Currently Operating Reactors	36
• New Reactors	37
New Reactor Types	38
New Reactor Vendors	38
Fuel Fabrication Demand Forecasts	40
• UxC Fabrication Market Demand Modeling	40
UxC Requirements Model (URM)	40
Use of URM Fabrication Demand Forecasts	40
• UxC Fabrication Demand Forecasts	41
Global LWR Fuel Fabrication Requirements	41
Regional LWR Fuel Fabrication Requirements	42

LWR Fabrication Requirements by Fuel Type	43
Conclusions from Demand Analysis.....	44
3 – Results from UxC Utility Fabrication Market Survey	45
State of the Market.....	45
Cycle Length	46
New Contract Scope	46
Procurement Lead Time.....	47
Procurement Approach	47
Vendor Qualification.....	48
Adequacy of Competition	48
Vendors Declining to Bid.....	49
Fuel Delivery Schedules and Inventories.....	49
Scope of Services Under Fuel Supply Contracts	50
Consistency of Supply.....	50
Acceptance of New Designs from Established Suppliers.....	51
Consideration of Accident Tolerant Fuels	51
Fuel Contracting Criteria	52
Major Industry Trends	52
Conclusions from Utility Survey.....	53
Lessons Learned.....	54
4 – The World’s Nuclear Fuel Fabricators	55
The Mega-Vendors.....	57
• Framatome.....	57
Framatome Emerges from AREVA	57
Impact on Framatome’s Fuel Fabrication Business	58
Ownership and Organization.....	58
Ownership.....	58
Current Organization.....	58
Fuel Business Unit (FBU) Overview.....	59
European Fuel Fabrication Operations	59
Production Facilities.....	59
Markets and Products	60
• TVEL Fuel Company Subcontract.....	61
Framatome’s Fuel Assembly Designs.....	62
U.S. Fuel Fabrication Operations	65
Production Facilities.....	65
Markets and Products	65
Accident Tolerant Fuel and Advanced Fuel Developments	66
Japanese Fuel Fabrication Operations	67
Chinese Fuel Fabrication Operations.....	67
Kazakh Fuel Fabrication Operations	67
Comprehensive Fuel Offerings.....	67
Possible Future Developments	68
• Global Nuclear Fuel (GNF)	70
Ownership and Organization.....	70
U.S. and European Fuel Fabrication Operations.....	70
Production Facilities.....	70
Markets and Products	71
• Strategic Alliance With TVEL Fuel Company	72
GNF’s Fuel Assembly Designs	72
Accident Tolerant Fuel Developments	74
Japanese Fuel Fabrication Operations	74
Production Facilities.....	74
Markets and Products	75
Comprehensive Fuel Offerings.....	76
Possible Future Developments	76
• Westinghouse Electric Company	77
Ownership and Organization.....	77
Ownership.....	77

Organization	77
• Regional Organizations	78
• Westinghouse Nuclear Fuel Division Overview	79
• Agreements and Joint Ventures with Foreign Suppliers	79
European Fuel Fabrication Operations.....	81
Westinghouse Electric Sweden, Västerås Nuclear Fuel Factory.....	81
Springfields Fuels, Ltd. – Preston, Lancashire, UK	81
Markets and Products	83
Westinghouse Fuel Assembly Designs	83
U.S. Fuel Fabrication Operations	84
Columbia Fuel Fabrication Facility	84
• Scrubber Incident.....	85
• Uranium Solution Leak	85
Windsor Fuel Components Facility.....	86
Markets and Products	86
Westinghouse Fuel Assembly Designs	86
Accident Tolerant Fuel Developments.....	89
VVER Fuel Fabrication Operations.....	90
Chinese Fuel Fabrication Operations	92
Comprehensive Fuel Offerings.....	92
Possible Future Developments.....	93
Emerging International Suppliers	94
• TVEL Fuel Company (TVEL)	94
Ownership and Organization	94
Production Facilities	97
MSZ – Elektrostal	97
NCCP – Novosibirsk.....	100
Plans for Expanding Fabrication Capability	101
Consolidation of TVEL Fabrication Activities	101
Technical and Engineering Support.....	102
Past, Present, and Future Markets	102
VVER Fuel Markets.....	103
PHWR Fuel Market	105
BWR and PWR Fuel Markets	105
• Framatome Subcontract	105
• TVS-KVADRAT – TVEL's PWR Reload Fuel Initiative	106
TVEL Technology and Fuel Designs	107
VVER-440 Fuel Assemblies	108
VVER-1000 Fuel Assemblies	109
Western PWR Fuel Assemblies	112
Accident Tolerant Fuel Developments.....	112
Possible Future Developments.....	113
• KEPCO Nuclear Fuel (KNF)	114
Ownership and Organization	114
Fuel Fabrication Operations	114
Current and Future Markets.....	117
Domestic Market	117
Foreign Markets	117
KNF Fuel Designs	119
Comprehensive Fuel Offerings	120
Possible Future Developments.....	121
Regional and National Fuel Suppliers.....	123
• ENUSA Industrias Avanzadas, S.A. (ENUSA) – Spain	124
Ownership and Organization	124
Fuel Fabrication Operations – Juzbado Nuclear Fuel Factory.....	125
Current and Future Markets.....	126
Spanish Market	126
Foreign Markets	126
ENUSA Fuel Assembly Designs.....	128
Comprehensive Fuel Offerings	129
Possible Future Developments.....	129
• Editor's Note on Japan.....	130
Potential Consolidation	130
• Mitsubishi Nuclear Fuel (MNF) – Japan.....	131

Ownership and Organization.....	131
Fuel Fabrication Operations.....	132
Japanese Operations – Tokai-mura Works.....	132
Foreign Operations.....	133
Current and Future Markets.....	133
Japanese Market.....	133
Foreign Markets.....	134
MNF Fuel Designs.....	134
Domestic Designs.....	134
US-APWR Fuel Assembly.....	135
Possible Future Developments.....	137
• Nuclear Fuel Industries (NFI) – Japan.....	138
Ownership and Organization.....	138
Fuel Fabrication Operations.....	138
Current and Future Markets.....	139
Japanese Market.....	139
Foreign Markets.....	139
NFI Fuel Designs.....	140
Possible Future Developments.....	141
• China National Nuclear Corporation (CNNC).....	142
Corporate Structure and Manufacturing Facilities.....	142
Fuel Fabrication Operations.....	143
Yibin Fabrication Plant.....	143
Baotou Fabrication Plant.....	144
Fuel Assembly Research & Development.....	145
New Fabrication Facilities.....	146
Other Fabrication-related Ventures.....	147
Current and Future Markets.....	148
Domestic Market.....	148
Foreign Markets.....	148
CNNC PWR Fuel Assemblies.....	149
Comprehensive Fuel Offerings.....	150
Possible Future Developments.....	151
• Industrias Nucleares do Brasil (INB).....	152
Ownership and Organization.....	152
Fuel Fabrication Operations – Resende Nuclear Fuel Factory (FCN).....	153
Current and Future Markets.....	153
INB Fuel Assembly Designs.....	153
Possible Future Developments.....	155
• Nuclear Fuel Complex – India.....	156
Ownership and Organization.....	156
Fuel Fabrication Operations.....	157
Possible Future Developments.....	158
• Kazatomprom – Kazakhstan.....	159
Ownership and Organization.....	159
Fuel Fabrication Operations – Ulba Metallurgical Plant.....	160
Historical Background.....	160
Fabrication Joint Ventures.....	160
• Framatome (formerly AREVA NP).....	160
• China General Nuclear Power Corporation.....	161
• Russia.....	161
• Ukraine.....	162
Ownership Share in Westinghouse.....	162
Production Capacity.....	162
Current and Future Markets.....	163
Western Fuel Fabricators.....	163
Japan.....	164
China.....	165
Possible Future Developments.....	165
• Nuclear Fuel – Ukraine.....	166
Ownership and Organization.....	166
Fuel Fabrication Operations.....	166
Joint Venture with TVEL.....	167
Possible Future Developments.....	168

• Fuel Manufacturing Plant – Iran.....	170
Possible Future Developments.....	170
Mixed Oxide (MOX) Fuel Fabrication.....	171
• France.....	171
• United Kingdom.....	173
• Japan.....	174
• United States.....	176
• China.....	177
• Russia.....	179
REMIX Fuel.....	180
Dual-Component Nuclear Power System.....	180
5 – Supply and Demand Analysis	182
Forecast of Supply Capability.....	182
Worldwide Supply and Demand.....	184
Western European Supply and Demand.....	187
North America/Taiwan Supply and Demand.....	189
Asian Supply and Demand.....	190
Supply and Demand for VVER Reactors.....	192
Other Supply Considerations.....	193
Conclusions.....	194
6 – Global and Regional Market Analysis	195
BWR Fuel Markets.....	196
• Western European BWR Fabrication Market.....	196
• North American BWR Fabrication Market.....	199
• Asian BWR Fabrication Market.....	200
Japan.....	200
Taiwan.....	202
PWR Fuel Markets.....	202
• Western European PWR Fabrication Market.....	202
French PWR Fuel Market.....	204
PWR Fuel Market in the Balance of Western Europe.....	205
Framatome Units.....	205
Siemens/KWU Units.....	206
Westinghouse Units.....	206
• U.S. PWR Fabrication Market.....	208
Babcock & Wilcox Units.....	209
Combustion Engineering Units.....	209
Westinghouse Units.....	210
• Asian PWR Fabrication Markets.....	211
Japan.....	211
Taiwan.....	212
South Korea.....	212
China.....	212
• Eastern European PWR (VVER) Fabrication Market.....	213
7 – Nuclear Fuel Fabrication Prices	214
Fuel Fabrication Price Background.....	214
Fuel Fabrication Price Formation.....	216
History of Fuel Fabrication Prices.....	217
Initial Core and Reload Batch Prices.....	219
Current and Future Fabrication Prices.....	219
• Utility Survey Responses.....	219
Current Fabrication Prices.....	219
Future Price Trends.....	220
• UxC Fabrication Price Forecast.....	222
Current Prices.....	222
Factors Affecting Future Prices.....	222
Developments Retarding Price Increases.....	223

Developments Promoting Price Increases	224
The Future Path of Fabrication Prices	225
• U.S. Fabrication Price Projections	226
• Prices Outside the U.S.	228
Western Europe	228
Japan	229
China and South Korea	229
VVER Fuel	229
8 – Non-LWR Fuel Fabrication Markets	230
Pressurized Heavy Water Reactor Fuel	230
• PHWR Overview	230
• PHWR Fuel Overview	231
• PHWR Fuel Fabricators	232
Cameco Fuel Manufacturing (Canada)	233
Description of Fabrication Facilities	233
Domestic and Foreign Markets Served	234
Fuel Assembly Designs and Services	234
BWXT Nuclear Energy Canada (Canada)	234
Description of Fabrication Facilities	235
Domestic and Foreign Markets Served	235
Fuel Assembly Designs and Services	235
KEPCO Nuclear Fuel (South Korea)	236
Description of Fabrication Facilities	236
Domestic and Foreign Markets Served	236
Fuel Assembly Designs and Services	236
China National Nuclear Corporation (China)	236
Description of Fabrication Facilities	236
Domestic and Foreign Markets Served	237
Fuel Assembly Designs and Services	237
Fabrica de Combustibil Nuclear (Romania)	237
Description of Fabrication Facilities	238
Domestic and Foreign Markets Served	238
Fuel Assembly Designs and Services	238
CONUAR S.A. (Argentina)	238
Description of Fabrication Facilities	239
Domestic and Foreign Markets Served	239
Fuel Assembly Designs and Services	239
Nuclear Fuel Complex (India)	239
Description of Fabrication Facilities	240
Domestic and Foreign Markets Served	240
Fuel Assembly Designs and Services	240
Additional PHWR Fuel Related Companies	241
SNC-Lavalin (Canada)	241
CNL (National Research Universal – NRU)	241
TVEL Fuel Company (Russia)	242
Kazatomprom (Kazakhstan)	242
• PHWR Fuel Supply and Demand Analysis	242
• PHWR Fuel Market Analysis	243
Gas Cooled Reactor Fuel	244
• GCR Overview	244
• Springfields Fuels Ltd. (AGR)	245
• AGR Fuel Supply and Demand	245
Light Water Cooled, Graphite Moderated Reactor Fuel	247
• LGR Overview	247
• LGR Fuel Overview	247
• LGR Fuel Supply and Demand Analysis	249
Small Modular and Advanced Reactor Fuel	251
• SMR Fuel Fabrication Overview	252
• Unique SMR Fuel Designs	253
• Summary	255

Appendix A – UxC 2018 Fuel Fabrication Market Survey Sample	256
Appendix B – Fuel Fabricator Contact Information	261
The Mega-Vendors	261
National and Regional Fuel Fabrication Suppliers	262
Glossary	263

List of Figures

Figure 1. LWR Fuel Demand vs. Supply: Before and After Fukushima	14
Figure 2. Map of UxC Nuclear Regions	31
Figure 3. UxC Nuclear Generating Capacity Forecast, 2008-2035	33
Figure 4. UxC Base, High, and Low Case Nuclear Capacity Forecasts, 2008-2035	35
Figure 5. Percentages of Different Operating Reactor Types	36
Figure 6. New Reactor Startups and Total MWe Added, 2018-2030	37
Figure 7. Percentages of New Reactor Types, 2018-2030	38
Figure 8. Percentages of New Reactor Vendors, 2018-2030	39
Figure 9. UxC Global LWR Fabrication Demand Forecast Cases, 2008-2035	41
Figure 10. UxC Regional LWR Base Case Fabrication Demand Forecast, 2008-2035	42
Figure 11. UxC Fabrication Demand Forecast by Fuel Type, 2008-2035	43
Figure 12. Utility Responses to Question on “Services Under Contract”	50
Figure 13. Framatome ATRIUM 10XM Fuel Assembly	62
Figure 14. Framatome AGORA H (left), HTP (center) and GAIA (right) Fuel Assemblies	63
Figure 15. Framatome ATRIUM 11 Fuel Assembly	64
Figure 16. GNF-A GNF2.02 Fuel Assembly	73
Figure 17. GNF-A GNF3 Fuel Assembly	73
Figure 18. Westinghouse SVEA Optima 2, Optima 3, and Triton11 Fuel Assemblies	87
Figure 19. Westinghouse RFA-2, NGF, CE16NGF, and AP1000 Fuel Assemblies	88
Figure 20. Westinghouse TVS-WR Fuel Assembly	92
Figure 21. Distribution of TVEL’s 2016 Consolidated Revenue by Types of Products	96
Figure 22. Geographic Distribution of TVEL’s 2016 Revenue from Nuclear Fuel Sales	96
Figure 23. MSZ’s VVER-1000 Fuel Fabrication Line	100
Figure 24. TVEL Fuel Assembly Offerings	108
Figure 25. TVEL VVER-440 TVS ARK Fuel Assembly (top) and RK-3 Assembly (bottom)	109
Figure 26. TVEL TVSA-12 and TVS-4A Fuel Assemblies	111
Figure 27. TVEL TVS-KVADRAT Fuel Assembly	112
Figure 28. KNF PLUS7 (left) and ACE7 (right) Fuel Assemblies	119
Figure 29. ENUSA 17x17 MAEF Fuel Assembly	129
Figure 30. MNF 17x17 Fuel Assembly	135
Figure 31. MNF US-APWR 17x17 Fuel Assembly	136
Figure 32. NFI 9x9 BWR Fuel Assembly	140
Figure 33. NFI 17x 17 PWR Fuel Assembly	141
Figure 34. First AP1000 Fuel Assemblies Produced in China	144
Figure 35. Chinese PWR Fuel Assemblies at CNNC’s Yibin Plant	149
Figure 36. CNNC’s CF3 Fuel Assembly	150
Figure 37. INB Fuel Assemblies at the Resende Plant	154
Figure 38. Russia’s Dual-Component Nuclear Power System	180
Figure 39. Projected Worldwide LWR Supply, 2008-2035	182
Figure 40. Worldwide LWR Fabrication Supply and Demand, 2008-2035	185
Figure 41. Western Europe LWR Fabrication Supply and Demand, 2008-2035	187

Figure 42. North American/Taiwan LWR Fabrication Supply and Demand, 2008-2035.....	189
Figure 43. Asian LWR Fabrication Supply and Demand, 2008-2035	190
Figure 44. VVER Fabrication Supply and Demand, 2008-2035.....	192
Figure 45. Western European BWR Fabrication Market Shares	197
Figure 46. North American BWR Fabrication Market Shares	199
Figure 47. Western European PWR Fabrication Market Shares	203
Figure 48. U.S. PWR Fabrication Market Shares.....	208
Figure 49. Total LWR Nuclear Fuel Price Breakdown	215
Figure 50. Utility Responses to Question on “Future Fabrication Price Trends”	221
Figure 51. BWR Fabrication Price Forecast, 2018-2035	227
Figure 52. PWR Fabrication Price Forecast, 2018-2035	227
Figure 53. PHWR Fuel Fabrication Manufacturing Process	231
Figure 54. PHWR Fuel Bundle	231
Figure 55. PHWR Fuel Fabrication Supply and Demand, 2008-2035	243
Figure 56. AGR Fuel Bundle	245
Figure 57. AGR Fuel Fabrication Supply and Demand, 2008-2035.....	246
Figure 58. RBMK-1000 Fuel Assembly	248
Figure 59. LGR Fuel Fabrication Supply and Demand, 2008-2030	250
Figure 60. HoltecSMR-160 Fuel Core Cartridge	253
Figure 61. China HTR-PM TRISO Coated Particles and Fuel Spheres.....	254
Figure 62. China’s Pilot HTR Fuel Production Line.....	254

List of Tables

Table 1. Reactor Units & Nuclear Capacities Anticipated by Country by 2035.....	33
Table 2. UxC Base, High, and Low Case Nuclear Reactor and Capacity Forecasts, 2018-2035	35
Table 3. Operating Reactor Types	36
Table 4. New Reactor Startups by Year, 2018-2030	37
Table 5. New Reactor Types, 2018-2030.....	38
Table 6. New Reactor Vendors, 2018-2030	39
Table 7. UxC Global LWR Fabrication Demand Forecast Cases, 2017-2030.....	41
Table 8. UxC Regional LWR Fabrication Demand Forecasts, 2017-2030	42
Table 9. UxC Regional LWR Fabrication Demand Forecasts, 2017-2030	43
Table 10. Survey Responses to Question on “State of the Market”	45
Table 11. Worldwide LWR Fuel Fabrication Capacity in 2018.....	56
Table 12. TVEL Fuel Production Levels, 2014-2017	97
Table 13. Base Case UxC Fabrication Supply Capacity Forecast, 2017-2030	184
Table 14. Number of European BWR Plants Supplied	197
Table 15. Number of Western European PWR Plants Supplied*	205
Table 16. Number of U.S. PWR Plants Supplied	209
Table 17. Historical Fabrication Prices, 2008-2017.....	218
Table 18. Fabrication Price Projection, 2018-2035	228
Table 19. Current Worldwide PHWR Fuel Fabrication Capacity.....	232
Table 20. Comparative Data for Ten Leading SMR and Advanced Reactor Designs	252
Table B-1. Mega-Vendor Fabrication Supplier Contacts.....	261
Table B-2. National and Regional Fuel Fabrication Supplier Contacts	262
Table C-1. Glossary of Terms	263

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