Fuel Fabrication Today-to-Tomorrow

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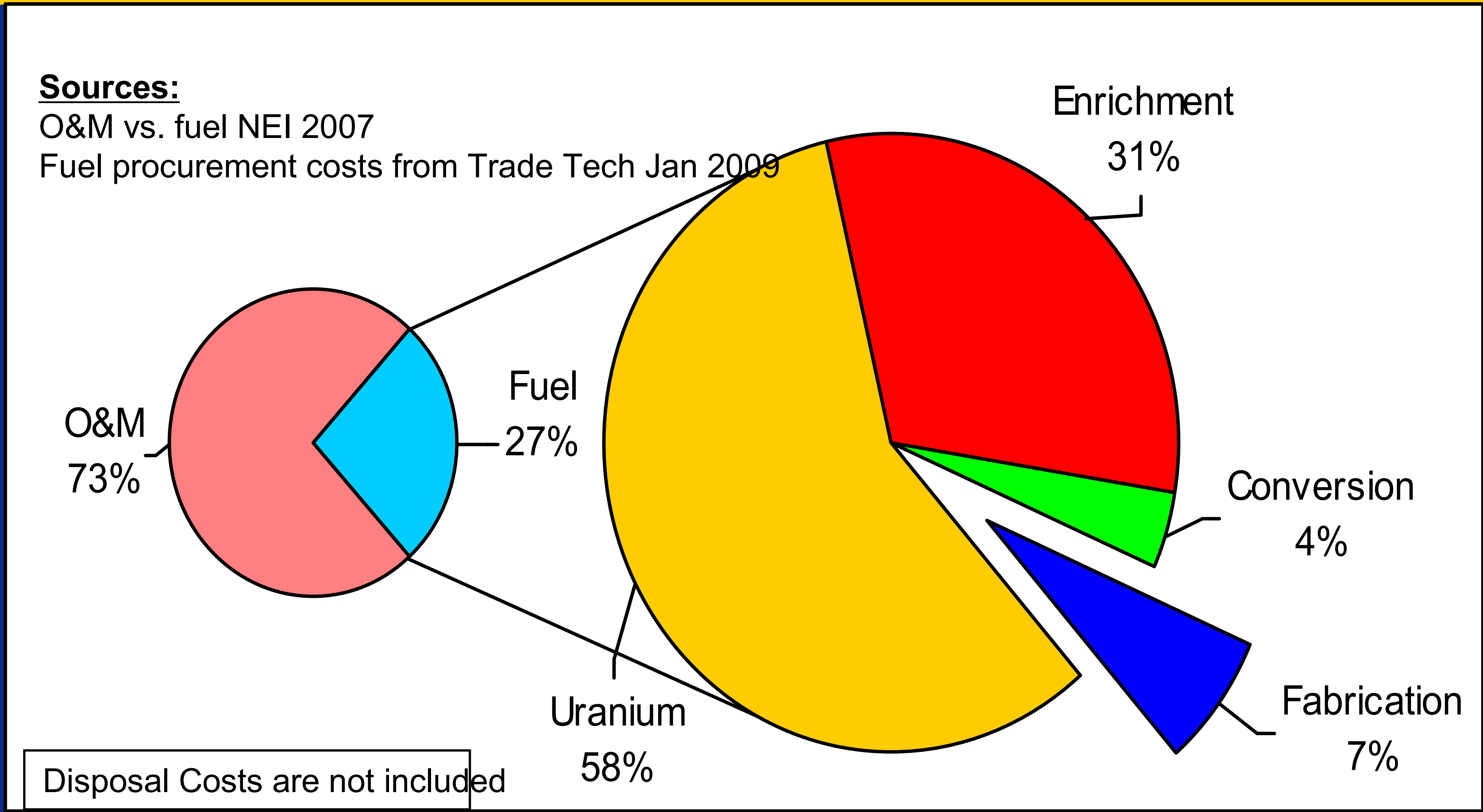
Fuel Fabrication Outline

- Fuel Value Chain
- Fuel Assembly Process
    - Manufacturing
    - Design
    - Engineering
- Global Capacity
- Prediction of Fuel Demand
- Assurance of Fuel Assembly Supply
- Conclusion

Overall Utility Nuclear Fuel Costs



Fuel Value Chain

Trade Tech Long Term Price Indicators, January 9, 2009

U3O8 → Conversion → Enrichment → Fabrication → Back-end

	U3O8	Conversion	Enrichment	Fabrication	Back-end
Unit Price	\$ 70/lb U3O8	\$ 12.25/KgUn	\$ 159/SWU	\$ 300/KgU	???
Price /KgU	\$ 2,047/KgU	\$ 137/KgU	\$ 1,114/KgU	\$ 300/KgU	???
Cumul.	\$ 2,047/KgU	\$ 2,184/KgU	\$ 3,298/KgU	\$ 3,598/KgU	
Percent	57%	4%	31%	8%	

For 1 KgU at 4.90 w/o and tails assay of 0.3 w/o

F/P = 11.192214 (KgUn / KgU)
S/P = 7.003813 (SWU / KgU)

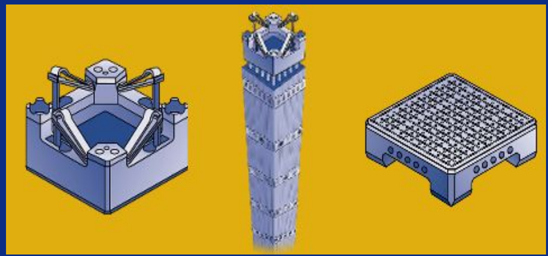
Key Elements for Fuel Fabrication and Engineering:

Fuel Assembly is an engineered product

- Engineering Technology

- Analytical Models
- Power Requirements
- Core Configuration
- Licensing

- Fuel Fabrication and Transport
- Components
- UF6 to UO2



- Powder/Pellets
- Rods
- Structural Components
- Final Fuel Assembly

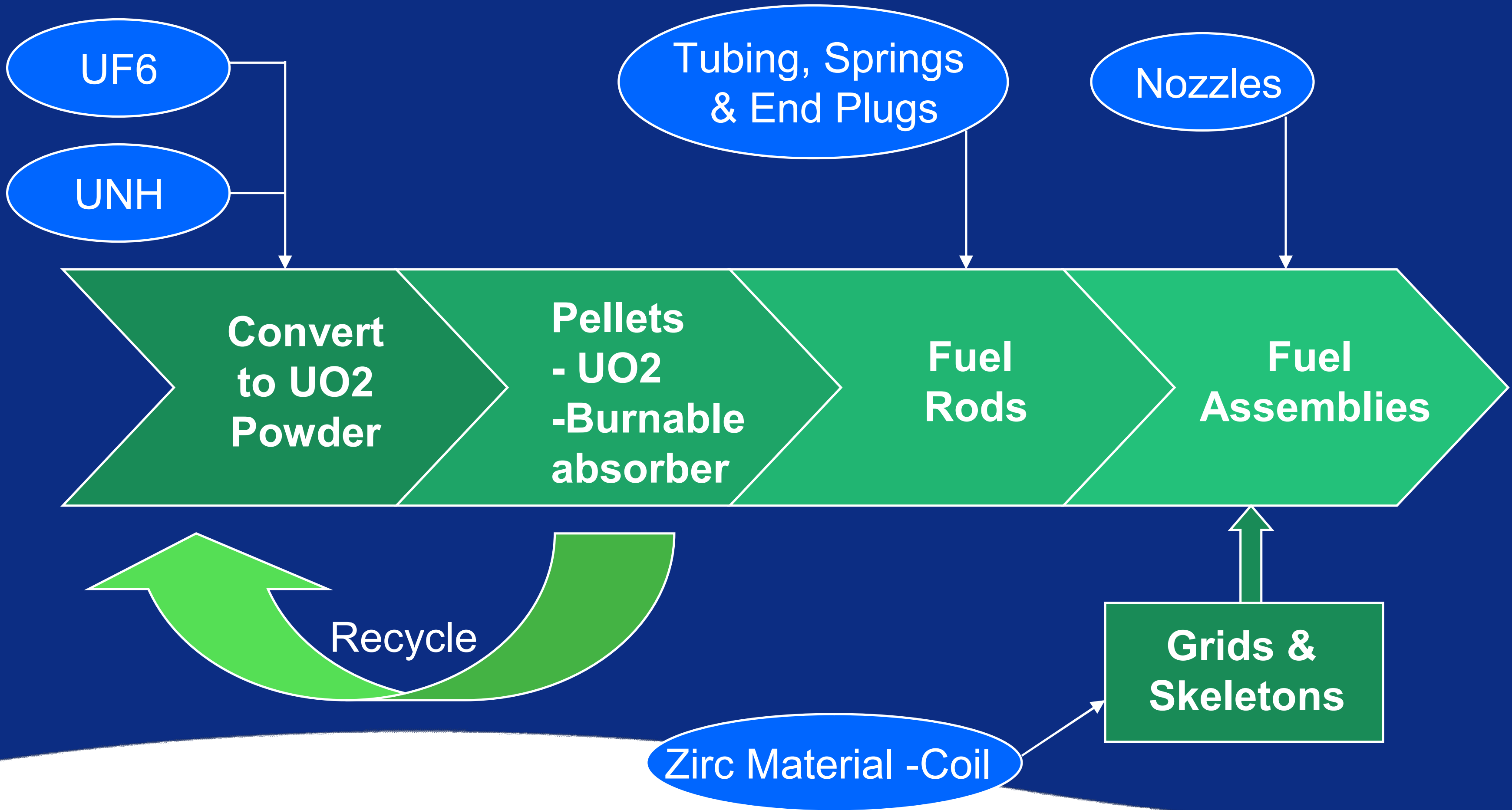
- Tubing

- Cladding

- Zirconium Products

- Material
- TREX, Coil, Bar

Fuel Fabrication Process



Fuel Assembly Technology

Fuel Design:

- **Analytical Model to simulate fuel assembly in the core**
  - *•Neutronic*
  - *•Mechanical/Material*
  - *•Thermal-Hydraluics*
  - *•Safety Analysis*

- **Separate Effect and Plant Test Data**
  - *•DNB*
  - *•Mechanical*
  - *•Material Corrosion*
  - *•Pressure Drop*
  - *•Temperature Profile*

- **Licensing**
  - *•Safety Analysis*
  - *•Regulatory Criteria*

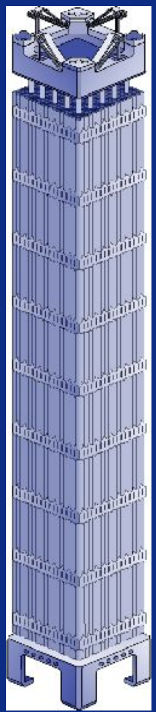
- **QA/QC**

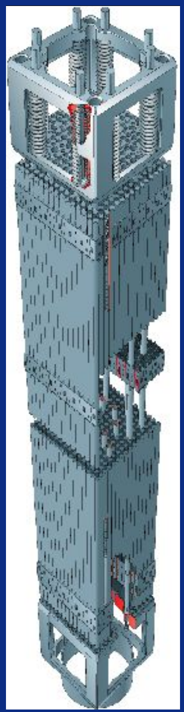
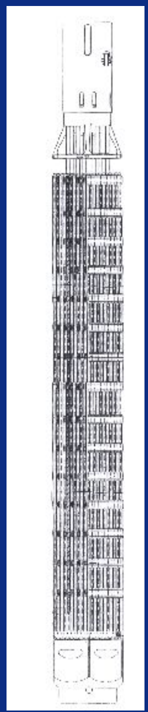
- **Fuel Performance**

•Power Requirements
  - *•Cycle Length*
  - *•Enrichment*
  - *•Number of Fuel Assemblies*
  - *•Operating parameters (shut down margin, burn-up)*

Fuel Designs:

Fuel Suppliers have different designs/materials/engineering methodology




LWR Current Fabrication

Nominal Plant Capacity
MTU/year

LWR Uranium Oxide Fabrication Facilities Nominal Plant Capacities MTU/Year (1/1/2008)

Country	Operator	Facility	Powder	Pellet	Assembly
Belgium	AREVA NP EU	Dessel	0	700	700
Brazil	INB-Resende	FCN Resende	165	120	240
China	Jianzhong	Jianzhong	400	400	450
France	AREVA NP EU	Romans	1200	820	820
Germany	AREVA NP EU	Lingen Fab	650	650	650
India	NFC-Hyderabd	Hyderabad	48	48	48
Japan	NFI-Kum/Tok	Kumatori	0	360	284
	MNF-TokaiMur	Tokai MNF	475	440	440
	NFI-Kum/Tok	Tokai NFI	0	250	250
	JNF-Yokosuka	Yokosuka	0	620	750

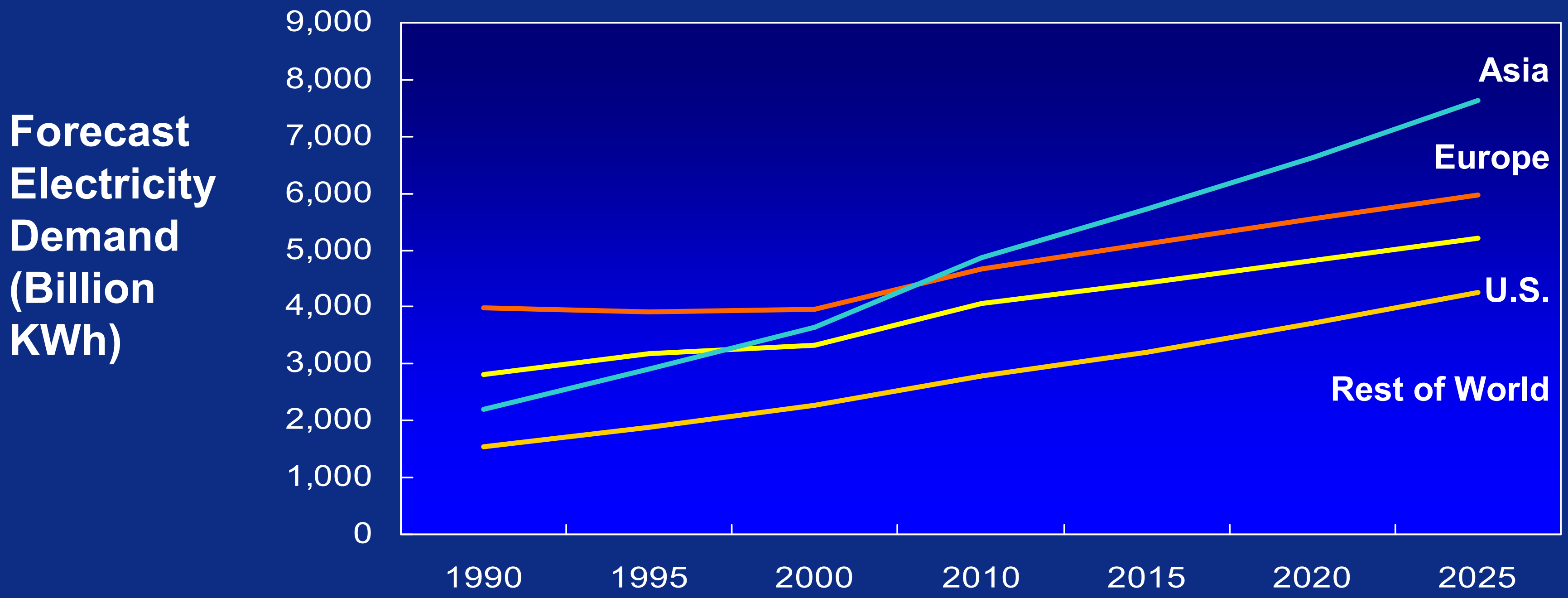
LWR Current Fabrication *(cont'd)*

Country	Operator	Facility	Powder	Pellet	Assembly
Kazakhstan	Kazatomprom	Ulba	3000	1000	0
Russia	TVEL-Ele/Nov	Elemash	1000	850	785
	TVEL-Ele/Nov	Novosibirsk	150	150	1000
South Korea	KNFC-Daejeon	Daejeon	600	600	600
Spain	ENUSA-Juzbad	Juzbado	0	400	400
Sweden	WestSE-Vas	Vasteras	530	530	400
U.S.A.	WestUS-Colum	Columbia Fab	1350	1500	1500
	AREVA NP US	Lynchburg	0	0	700
	AREVA NP US	Richland	1800	700	700
	GNF-Wilmingt	Wilmington	1000	1100	1100
United Kingdom	WestUK-Sprin	Springfields	440	440	0
Total		**MTU/Year**	**12808**	**11678**	**11817**

* Source NAC

Nuclear Renaissance

- Growing demand for clean, safe electricity



Today’s Regional LWR

Demands vs. Capacity

	Demand (MTU/yr)	Capacity (MTU/yr)
US:	~2200	~4000
Western Europe:	~2000	~3500
Asia:	~1250	~1500

Growth Projections for Nuclear Power

EIA 2008 Data:

Global Increase ~150 GWe by 2025

WNA Data:

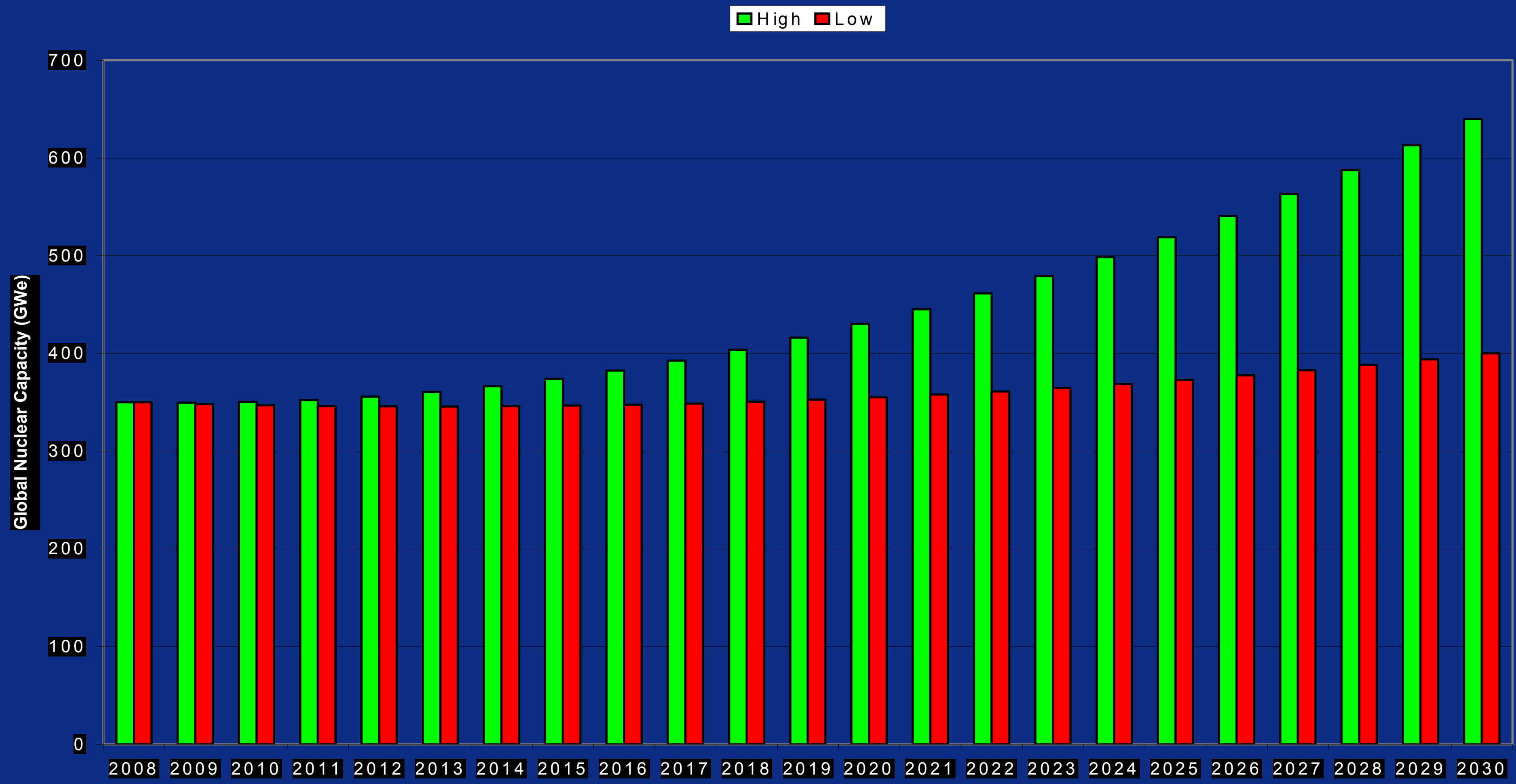
Global Increase	~80 GWe by 2020
	~150 GWe by 2030

IAEA 2008 Data:

Global Increase by 2030

Low End:	~60 GWe
High End:	~300 GWe

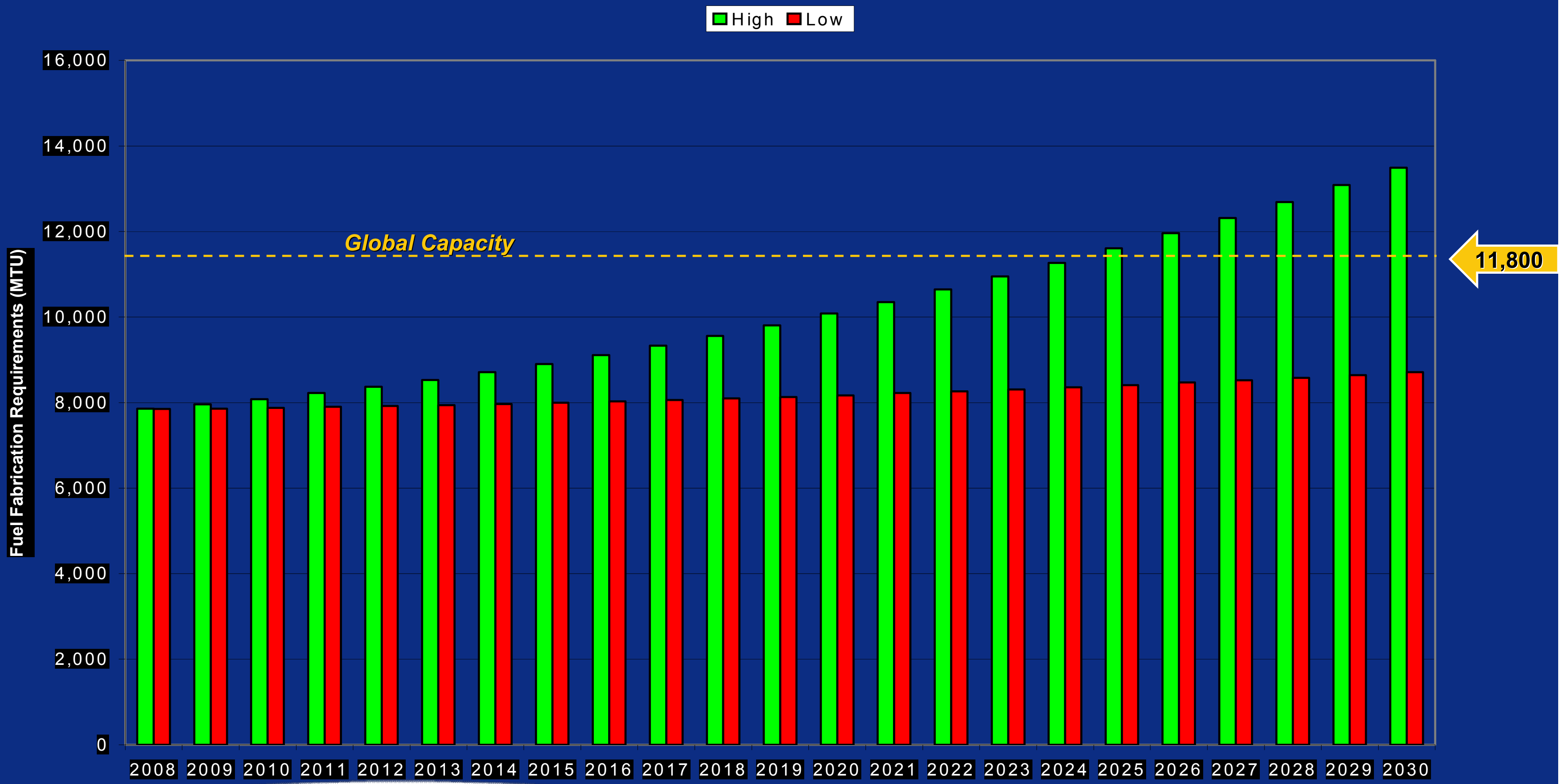
NEA Projections: *GWe Growth Range*



NEA Projections**

***NEA, Nuclear Engineering Outlook 2008*

Projection for MTU of Fabricated Fuel



Projection for MTU of Fabricated Fuel*

Fuel Design/License/Fabrication

To answer the question regarding demand vs. capacity, questions on a local basis need to be answered:

Where will the demand for fuel assemblies be by country?

How big will the demand be by country?

What new plant design is to be chosen?

Where is the capacity to serve the demand?

Will countries develop indigenous capability?

These questions require a country-by-country assessment from the perspective of growth rate, capacity strategy, government aspects and available options.

Fuel Assembly – Demand vs. Capacity

- Somewhat different than uranium (U308) or enrichment, the final fuel assembly is likely to be different from one supplier to another, either because of design, material, license …

- Fuel Assembly is an engineered product

- Fuel Assembly Supply is much more “local” than “global”
  - ✓*Licensing*
  - ✓*Design*
  - ✓*Transportation*
  - ✓*Governmental Requirements*
  - ✓*New Plant Design*

Risk – Assurance of Fuel Assembly Availability

- A fuel supplier having the ability to manufacture specific fuel design in multiple countries.
  - Cross Qualification of Designs
  - Integrated Engineering Methodology

- Ability to use fuel supplier licensees to manufacture and perform the engineering analysis.

- Potential to expand licensee rights beyond local boundaries

- Potential Strategic Inventory of fuel assemblies

Conclusions

•Capacity growth studies are highly variable
50 GWe - >300 GWe

•Current and Planned Global Capacity available for significant increase in new plants, however, only from a global aspect.

•Local capacity will be required to address regional growth.

•Transportation capability is an important element to achieve better globalization

•Local or Regional production is likely more important than global availability which can result in capacity short falls