Discussion Points

1. URENCO – A brief introduction
2. LEU+ & HA-LEU – Working Definitions
3. Completing the Future Nuclear Fuel Supply Chain
4. Implementation of HA-LEU Enrichment at UUSA
5. Transport & Packaging Challenges
6. A Call to Action
7. Closing Remarks
URENCO – A Global Supplier
Capacity of 18,500 tSW/year

Capenhurst, UK
Capacity: 4,600 tSW/year

Almelo, The Netherlands
Capacity: 5,200 tSW/year

Head Office
Stoke Poges, United Kingdom

Eunice, USA
Capacity: 4,800 tSW/year

Gronau, Germany
Capacity: 3,900 tSW/year
UUSA Today

- Located in southeast New Mexico on the boarder with Texas.
- NRC license issued in 2006 with operations commencing in 2010.
- First new nuclear facility in the US for more than 30 years.
- Only operating uranium enrichment plant in North America.
- Supportive community and New Mexico state legislature.

UUSA Future

- Available space on existing Category III nuclear licensed site for additional facilities.
- Scope for expansion to accommodate Category II Facility – HA-LEU.
- URENCO Technology Centre – laboratory.
- URENCO Advanced Nuclear Fuel Campus:
  - Co-location of facilities for the production of next generation.
  - Shared facilities, services and security.
URENCO Working Definitions: LEU / LEU+ / HA-LEU

**U235 Enrichment Levels**

- **Feed 0.711%**
- **Natural Uranium**
- **LEU <5%** Civil Nuclear Reactors
- **LEU+ 5% - 10%** Extended Fuel Cycles & ATFs
- **HA-LEU 10% - 20%** Test, Research and Gen IV Reactors

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**Cumulative SWU required to reach 20% Enrichment**

- **Effort - SWU per Tonne of Feed**
- **Product Assay - U235 Content (%)**

- **Physical Security**
  - Cat 2 Facility
  - Cat 3 Facility

- **LEU**
- **LEU+**
- **HA-LEU**
The Future Nuclear Fuel Supply Chain

**Existing Nuclear Fuel Supply Chain**

- **Mining** → $\text{U}_3\text{O}_8$
- **Conversion** → $0.711\% \text{UF}_6$
- **Enrichment** → $<5\% \text{LEU}$
- **Fabrication** → $\text{UO}_2$

**Back End**

**Spent Fuel**

**LWR Reactors**

$\text{UO}_2 / \text{ZircAlloy Fuels}$

**Completing the Future Nuclear Fuel Supply Chain**

- **Enrichment** → $0.711\% \text{UF}_6$
- **Deconversion** → U-metal U-oxide U-salts
- **Transport Package**
- **Higher Enrichment** → $<5\% \text{LEU}$
- **Deconversion** → $5\%-20\% \text{LEU+ HA-LEU}$

**Fabrication**

**Next Generation Fuels**

- TRISO, Uranium Nitride, Uranium Silicide, U-metal Alloys
- $\text{UF}_4$ Salts

**Preferable option to co-locate**

**Gen III+, ATFs**

- SMRs, GenIV,
- Advanced Reactors

**Research & Test Reactors**
A sustainable HA-LEU fuel cycle includes three fundamental capabilities:

1. Higher Enrichment Facility
   • to produce HA-LEU in the form of uranium hexafluoride ($\text{UF}_6$) up to 19.75%

2. Deconversion Facility
   • to (de)convert HA-LEU $\text{UF}_6$ into U-metal, U-oxides and/or U-salts

3. Fabrication Facilities
   • to manufacture the specific fuel types required by the various reactor designs

Packaging and transportation solutions are also required:

• A certified transport package (cylinder and protective overpack) will need to be developed to store and transport production volumes of HA-LEU as $\text{UF}_6$
Implementation of HA-LEU Enrichment at UUSA

No “Show Stopper”:

• There are **no treaty considerations or export control restrictions** associated with HA-LEU production at UUSA.

• **URENCO’s existing advanced gas centrifuges are capable** of producing the full span of HA-LEU enrichments without further development or testing.

• **We estimate that if detailed design, site permits, and contractor selection were undertaken in parallel with the regulatory licensing process, we could construct, commission and start-up a **HA-LEU production unit within 24 months of regulatory licensing approval.**
‘3-Box’ Model:
- Co-location of higher enrichment, deconversion and fuel fabrication facilities.
- Satisfying the requirements of a number next generation fuel types for HA-LEU.
- Leverages existing site characterization data, site infrastructure, and regulator familiarity

5% - 10% UF₆

Next Generation Fuel Manufacturing Facility

Higher Enrichment Facility

0.711% ENU

UF₆ Deconversion Facility

<19.75% UF₆

<19.99%
U-metal
U-oxide
U-salts

Fabricated HA-LEU Fuels

TRISO (UCO)
UO₂
U-metal alloys
UF₄ salts
Uranium nitride
Uranium silicide

(Cat II License)
Addressing the issues related to the transport of enriched uranium between 5% and 20%, there are a number of steps required to arrive at a viable long-term solution:

**Government and Industry should look at this question as two distinct pathways**

1. **LEU+ (5% -10%)**
   - Either: Use of existing 30B cylinder with DN30 overpack:
     - Requires analytical confirmation for regulatory/license exemption to 10% as a long-term solution
     - DN30 overpack can be demonstrated to be a safer and more robust option over the UX-30
   - OR: Development of a New Cylinder with moderation control
     - Requires Industry and Regulatory backing for design, testing and manufacture of a long-term solution

2. **HA-LEU (10% - 20%) - use of existing 5B cylinder:**
   - Requires development of a modified DN30 overpack with integrated 5B storage racks
   - May need development of a more robust solution with increased capacity as HA-LEU volumes develop

<table>
<thead>
<tr>
<th>Cylinder Model</th>
<th>Diameter (inches / mm)</th>
<th>Maximum Enrichment</th>
<th>Maximum UF6 (lbs / kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1S</td>
<td>1.5 / 38.1</td>
<td>100.00%</td>
<td>1.0 / 0.5</td>
</tr>
<tr>
<td>2S</td>
<td>3.5 / 88.9</td>
<td>100.00%</td>
<td>4.9 / 2.2</td>
</tr>
<tr>
<td>5B</td>
<td>5.0 / 127</td>
<td>100.00%</td>
<td>54.9 / 24.9</td>
</tr>
<tr>
<td>8A</td>
<td>8.0 / 203.2</td>
<td>12.5%</td>
<td>255 / 115.7</td>
</tr>
<tr>
<td>30B</td>
<td>30 / 762</td>
<td>5%</td>
<td>5020 / 2277</td>
</tr>
</tbody>
</table>
A call to action

Industry Task Force

NRC, DOT, National Labs, Industry Groups, Enrichers, Fabricators, Utilities

- Leadership to prioritize the issues, develop the project plan and channel resources
- Aggregate demand and specifications of reactor developers
- Make a consistent and coherent ask of Government

The Role of Government

- Sustained and dedicated funding:
  - Special funding profile so that interdependent projects are not competing for the same finite resource, i.e. Next Generation Fuels vs Advanced Reactors vs Transport.
- DOE “Wholesale Buyer” of HA-LEU
  - Purchase of initial HA-LEU output to enable industry to invest in commercial facilities of a minimum economic scale ahead of nascent demand.
Closing Remarks

1. It is imperative that the enrichment, deconversion and fabrication facilities - and the concordant packaging solutions - be developed on concurrent schedules.

2. Regulatory resources are required to support the licensing framework needed for the development of a HA-LEU fuel cycle.

3. The timing of front-end fuel cycle development for next generation fuels must match the forecast aggregate demand of advanced reactor vendors coming to market.

4. Companies making investments in HA-LEU facilities need to be sufficiently assured of a reasonable and necessary economic return.

5. There is a role for national Governments and NGOs to both stimulate and facilitate this exciting next phase in the growth of the nuclear industry.
Thank You

For additional information on URENCO’s Next Generation Fuels please contact:

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