Uranium Resource availability Assessment for Niger’s Nuclear Energy System by INPRO Methodology

INPRO Dialogue Forum 8, Vienna 26-29 August 2014

By DJIBO TAKOUBAKOYE DAOUDA
Director of Nuclear Energy Departement
Haute Autorité Nigérienne à l’Energie Atomique (HANEA)
Présidence de la République du Niger

e-mail: djibo@me.com
Mobile: +227 96 66 44 98
I. Objectives of this presentation
II. Country Profile
III. Specification of the Nuclear Energy System
IV. Resources Classification schemes used by INPRO and other Institutions
V. Quantity of uranium Fu available for use in NES
VI. Quantity Du of Uranium needed for NES
VII. Conclusion
I. **Objectives of this presentation**
II. Country Profile
III. Specification of the Nuclear Energy System
IV. Resources Classification schemes used by INPRO and other Institutions
V. Quantity of uranium Fu available for use in NES
VI. Quantity Du of Uranium needed for NES
VII. Conclusion
Objectives:

This presentation aims to:

- Compare Niger and INPRO Standards of resources Classification
- Assess and Report Niger’s conventional primary Identified resources of Uranium
- Verify the CR1.1 of UR1 of INPRO methodology fulfillment by Niger’s NES
OUTLINE

I. Objectives of this presentation

II. Country Profile

III. Specification of the Nuclear Energy System

IV. Resources Classification schemes used by INPRO and other Institutions

V. Quantity of uranium Fu available for use in NES

VI. Quantity Du of Uranium needed for NES

VII. Conclusion
Country Profile: Location

Niger in Africa
Country profile (Cont.)

- Republic of Niger
- Capital: Niamey
- Land area: 1,267,000 km²
- Population²: more than 17 millions inhabitants
- Mining Industry²: major part of country economy (40% of exports) and 3% GDP and employs permanently more thousand people
- Uranium represents more than 60% of exportation Niger is interested in Nuclear Science and Technics and their pacific applications since 60’s
- We have created in the 60’s IRI (Institut des radio Isotopes) for training and research in the field
- We are part of NPT (Non Proliferation of nuclear weapons Treaty)
- Part of the CTBT (comprehensive nuclear test ban treaty)
- Niger has announced his intention to develop a Nuclear Energy Program since 2010

Source: Institut National de la Statistique
I. Objectives of this presentation
II. Country Profile
III. Specification of the Nuclear Energy System
IV. Resources Classification schemes used by INPRO and other Institutions
V. Quantity of uranium Fu available for use in NES
VI. Quantity Du of Uranium needed for NES
VII. Conclusion
Niger’s NES is at the front end of Nuclear fuel production chain it consist of Mining and Milling.

Niger has three (03) operating mines: SOMAIR, COMINAK and SOMINA each company has its own processing Mill plant therefore Niger has three mining and three milling facilities.
I. Objectives of this presentation
II. Country Profile
III. Specification of the Nuclear Energy System
IV. Resources Classification schemes used by INPRO and other Institutions
V. Quantity of uranium $F_u$ available for use in NES
VI. Quantity $D_u$ of Uranium needed for NES
VII. Conclusion
Organisations and Countries use different methods of classifying resources but the various systems have several features in common:

- They all define ‘Mineral Resource’ as concentration or occurrence of material of intrinsic economic interest in or on the earth crust in such form that there are reasonable prospect for eventual economic extraction.

- They differentiate the resource in two main groups (Known and Undiscovered).

- They all subdivide undiscovered resources in two classes: one with a well known geology containing defined deposits and one highly uncertain with a less known area containing speculative resources.

IAEA has strived to develop a comprehensive inventory of recoverable uranium resources since 1960's.
INPRO uses the system of classification developed by IAEA and NEA (Nuclear Energy Agency) of OECD (Organisation for Economic Co-operation and Development) to prepare the inventory of uranium resources published in the world report of uranium known as Red Book.
The Red Book defines category of uranium that could be mined (called Primary resources in opposition to secondary supply resources) based on confidence level in the quantities reported and cost to mine.

It defines the primary resources in two broad classes:

- Conventional resources: those that have an established history of uranium producing as a key product or an important by-product.

- Unconventional resources: those from which uranium is only recoverable as a minor by-product (phosphate mining).

Conventional resources are divided according to different confidence levels of occurrence into 4 categories:
Reasonable Assured Resources (RAR), Inferred Resources (IR), Prognostical Resources (PR) and Speculative Resources (SR).

RAR + IR = identified resources
PR + SR = undiscovered resources
NEA/IAEA Cost categories for uranium resources

The Red Book also defines four categories of costs in USD of uranium recovered at the ore processing plant:

\(<\text{USD} \ 40/\text{KgU}, \ <\text{USD} \ 80/\text{KgU}, \ <\text{USD} \ 130/\text{KgU}, \ \text{and} \ <\text{USD} \ 260/\text{KgU}\)

The following therefore gives the 13 classes for U resources/reserves according to the Red Book scheme.
### IEA/IAEA classification scheme for uranium resources

<table>
<thead>
<tr>
<th>Identified Resources</th>
<th>Undiscovered Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>USD</strong></td>
<td><strong>Prognosticated Resources</strong></td>
</tr>
<tr>
<td><strong>&lt; 40</strong></td>
<td><strong>SPECULATIVE RESOURCES</strong></td>
</tr>
<tr>
<td><strong>&lt; 80</strong></td>
<td></td>
</tr>
<tr>
<td><strong>&lt; 130</strong></td>
<td></td>
</tr>
<tr>
<td><strong>&lt; 260</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Increasing Economic attractiveness**

**Decreasing confidence in estimates**
UNFC/CRIRSCO resources classification scheme

In 2009 United Nations Economic Commission for Europe (UNCE) developed a classification scheme called UN framework Classification (UNFC) it is based on three fundamental criteria: economic (E), field project status and feasibility (F) and geological knowledge (G). According to UNFC each project is categorised by a combination of three numbers (111, 112, 211 etc.).

Committee for Mineral Reserves International Reporting Standards (CRIRSCO) has classified resources in two main classes: Exploration Results and Mineral resources which is divided into indicated and measured resources. According to CRIRSCO Mineral reserve are part of mineral resources that are economically, technically, environmentally minable and are divided into probable reserve and proved reserve.
CRIRSCO Relationships between Mineral Resource and Reserve

- Exploration Results

- MINERAL RESOURCES
  - Indicated
  - Measured

- MINERAL RESERVES
  - Probable
  - Proved

Increasing level of geological knowledge and confidence

Consideration of mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors (the "Modifying Factors").
## NEA-IAEA/CRIRSCO Schemes Comparison

<table>
<thead>
<tr>
<th>Identified Resources</th>
<th>Undiscovered Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NEA-IAEA used by INPRO for Resource assessment</strong></td>
<td>Reasonably Assured</td>
</tr>
<tr>
<td><strong>CRIRSCO Used by Niger and Canada mining companies</strong></td>
<td>Measured</td>
</tr>
<tr>
<td><strong>United States (DOE)</strong></td>
<td>Reasonably Assured</td>
</tr>
<tr>
<td><strong>UNFC</strong></td>
<td>G1+G2</td>
</tr>
</tbody>
</table>

**SPECULATIVE RESOURCES**
I. Objectives of this presentation
II. Country Profile
III. Specification of the Nuclear Energy System
IV. Resources Classification schemes used by INPRO and other Institutions
V. Quantity of uranium Fu available for use in NES
VI. Quantity Du of Uranium needed for NES
VII. Conclusion
Quantity of uranium $F_u$ available for use in NES: Conventional primary Identified Resources
Undiscovered Uranium resource

- Niger's first commercial uranium mine began operating in 1971.
- Niger has three significant uranium mines providing 7.5% of world mining output from Africa's highest-grade uranium ores. (COMINAK, SOMAIR, SOMINA)
- Six (06) junior companies are active in uranium exploration (GPB Minerals, Global Atomic Fuels, GoviEx, Niger Uranium, NGM)
- There is strong government support for expanding uranium mining.
- Niger is the world fourth uranium producer in 2013 it produces 4,528 tU and cumulative production from the country is 123,541 tU.

- Undiscovered Uranium resources are mainly in the Tim Mersoi Sedimentary Basins that covers more than 114,000 Km² and has a potential resource estimated at of 480,000 tones of uranium* with grade comprising between 0.3 and 0.6 %

* Source: Présidence de la République du Niger www.presidence.ne
### Inferred resources

The total inferred resources evaluated in Niger in 2013 is more than 83,000 tU:

<table>
<thead>
<tr>
<th>Project</th>
<th>Inferred (tU)</th>
<th>Year of estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imouraren</td>
<td>2,879</td>
<td>2009</td>
</tr>
<tr>
<td>SOMAIR</td>
<td>41,230</td>
<td>2011</td>
</tr>
<tr>
<td>COMINAK</td>
<td>2,239</td>
<td>2011</td>
</tr>
<tr>
<td>SOMINA</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>GOVIEX</td>
<td>9,200</td>
<td>2010</td>
</tr>
<tr>
<td>Gloabl Uranium</td>
<td>21,000</td>
<td>2011</td>
</tr>
<tr>
<td>Niger Uranium</td>
<td>1,700</td>
<td>2011</td>
</tr>
<tr>
<td>NGM</td>
<td>5,000</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>83,248</strong></td>
<td></td>
</tr>
</tbody>
</table>

Sources: Ministry of Mine World Nuclear Energy
Reasonably assured reserves

In 2014 the country RAR resources that can be mined less than 130 USD/Kg is estimated to 278,143.2 tU reported by the following companies:

<table>
<thead>
<tr>
<th>Project</th>
<th>R.A.R (tU)</th>
<th>Year of estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imouraren</td>
<td>213,722</td>
<td>2013</td>
</tr>
<tr>
<td>SOMAIR</td>
<td>38,211</td>
<td>2009</td>
</tr>
<tr>
<td>COMINAK</td>
<td>14,062</td>
<td>2013</td>
</tr>
<tr>
<td>SOMINA</td>
<td>12,148.20</td>
<td>2014</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>278,143.2</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Ministry of Mines
Quantity of uranium $F_u$ available for use in NES

The total amount of $F_u$ of uranium available for the NES is estimated to be more than 841,000 tones uranium. This is the quantity of uranium available today at a cost < $260 \text{ USD/KgU}$.

It consists of the sum of Prognosticated uranium resource, Inferred uranium resource, and Reasonably Assured Resource.

\[ F_u = 480,000 \text{ tU} + 83,248 + 278,143.2 \text{ tU} = 841,391.2 \text{ tU} \]
OUTLINE

I. Objectives of this presentation
II. Country Profile
III. Specification of the Nuclear Energy System
IV. Resources Classification schemes used by INPRO and other Institutions
V. Quantity of uranium Fu available for use in NES
VI. **Quantity Du of Uranium needed for NES**
VII. Conclusion
Although the country has no nuclear power plant it supplies the global market an important part of its uranium need hence Niger is the world's fourth-ranking producer of uranium in 2013 and produced 4,528 tonnes of Uranium in its three (3) mines:

- Société des Mines de l’Aïr (SOMAIR), an open pit mine
- Compagnie Minière d’Akouta (COMINAk) that is an underground mine operating at a depth of about 250 metres
- Société des Mines d’Azélik (SOMINA) which is an open pit and underground operation using alkaline leach
In 2011 total production of Niger (Du needed in the NES for global market) was 3,865 tU. It has significantly increased in 2012 (around 7.7%) at 4,667 tU. And, it decreased (around 3%) in 2013 to 4,528 tU.
I. Objectives of this presentation
II. Country Profile
III. Specification of the Nuclear Energy System
IV. Resources Classification schemes used by INPRO and other Institutions
V. Quantity of uranium Fu available for use in NES
VI. Quantity Du of Uranium needed for NES
VII. Conclusion
Conclusion:

Niger’s NES resource availability fulfills the INPRO criteria CR.1.1 of User Requirement UR1 since that with more than 841,000 tones (Fu) of primary uranium resources and assuming today’s production capacity less than 5,000 tU/year (Du) Even when any new deposit is discovered over years one can estimate that Niger will continue producing uranium for more than 168 years without running out of resources

Then \( Fu(t) > Du(t) \) for any \( t < 100 \) years !
THANK YOU!