Uranium Extraction from Phosphates:
- Background, Opportunities, Process Overview & Way Forward for Commercialisation

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Outline of Presentation

- Sustainable Development & Nuclear Technology
- Why Uranium from Phosphate?
- Opportunities & Challenges
- Process & Technology Overview
- Way-forward for Commercialisation
## Basic Social needs: 2014 Vs 2050

<table>
<thead>
<tr>
<th>Category</th>
<th>2014</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>World Population</td>
<td>7.2 billions</td>
<td>9.6 billions</td>
</tr>
<tr>
<td>No access to Electricity</td>
<td>2 billion</td>
<td>?</td>
</tr>
<tr>
<td>No access to safe &amp; reliable water</td>
<td>768 million</td>
<td>? (demand 55% higher)</td>
</tr>
<tr>
<td>No access to sanitation</td>
<td>2.5 billion</td>
<td>?</td>
</tr>
<tr>
<td>Food Demand</td>
<td>2.2 billion tonnes</td>
<td>3 billion tonnes</td>
</tr>
</tbody>
</table>
We all love Peace ....
Must ensure basic minimum needs of society worldwide is met!

**Prerequisite:**

- Sustainable & Balanced socio-economic growth across the World
- Improved standard of living cutting across National Boundaries
  - Affordable Food
  - Affordable Energy
  - Safe & reliable water source
  - Clean Environment
Solution?...
Nuclear Technology offers immense benefit to Society

Contribution to Sectors :-

- Electricity
- Food & Agriculture
- Environment & Health
- Water Resource Management
- Urban Waste & Sewage Management
Why Uranium from Phosphate?

- Sustainable Socio-economic development across the Globe will encourage large growth in Nuclear Technology
- Current Uranium Requirement: 65000 MT/yr (Primary 60%, Secondary 40%)
  - Projected Growth: 10 times by 2060, 30 times by 2100
- Economically recoverable Primary Resource: 5.5 million MT
- Additional Primary Resource at higher price: 10.5 million MT
- Need to look beyond Primary resource
  - Potential availability from phosphate: 22 million MT
  - Enables recovery of energy resource - otherwise lost forever
Basic schematic for U-Recovery from Phosphate

- U-recovered from Phosphate can meet 15% of global nuclear fuel requirement
- U-recovered in 5 days can support 1000 MW nuclear power generation for a year
- If not recovered, 35 to 40 MT uranium goes into soil everyday
Uranium Extraction from Phosphate
- an Attractive proposition

- Uranium is co-product of phosphate Industry and makes phosphate Industry economically viable & socially more acceptable

- Enable utilisation of mineral deposits having low Phosphate value through economic co-production of Phosphatic fertiliser & Uranium

- Bring new countries in global map of Uranium resources

- Enables socio-economic up-gradation of major part of global population by achieving Energy, food & Environmental security - so important in today’s scenario
Socio-economic attraction

- No additional Mining
- No separate ore processing
- Feed available from Phosphate Industry almost in ‘ready to use’ condition
- Recovers ‘energy Resource’ through ‘comprehensive extraction’ of minerals already mined
- Has potential for ‘reduced mining needs’ by lowering dependence on primary resource of Uranium or fossil fuel
Impact on Environment

- No ‘tailing’ disposal! No bulk waste generation.
- Has potential for reduction in disposal of ‘tailing’ from ‘primary resource’ due to lower dependence.
- Will reduce soil contamination by removing Uranium from Phosphatic fertiliser.
- Promote ‘sustainable development’ by conserving natural resource for generation next.
Win – Win Scenerio

Hungry gets Food

Needy gets Energy

Phosphatic Fertiliser Community

U to Nuclear Fuel Cycle

Nuclear Community

Humanity gets clean environment
Challenges to be addressed

**Process**

- Wide variation in feed characteristics, chemistry & impurity profile
- Low Uranium concentration in ore
- Extraction, enrichment & purification involve several ‘chemical processes’ & ‘unit operations’ involving Solvent-Extraction

**Economic**

- Require high plant throughput & several steps of enrichment
- Resultant large plant volume & large inventory calls for high Capital & Operating costs

**Opportunity**: Previous experience exist. Persons having expertise from previous campaigns willing to help.
### Two prospective processes

<table>
<thead>
<tr>
<th>SX (Liquid – Liquid)</th>
<th>IX (Solid – Liquid)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Process / Equipment</strong></td>
<td>Conventional, Proven, Flexible, Simple</td>
</tr>
<tr>
<td><strong>Safety / Environment</strong></td>
<td>Fire</td>
</tr>
<tr>
<td><strong>CAPEX / OPEX</strong></td>
<td>High</td>
</tr>
<tr>
<td><strong>Industry experience</strong></td>
<td>Proven</td>
</tr>
<tr>
<td><strong>Life-cycle performance</strong></td>
<td>Data Available</td>
</tr>
</tbody>
</table>

Prudent to use S-X process for immediate Industrial Applications
Process requirements in simple terms

- **Increase in U-concentration**
  - Feed concentration: 100 ppm = 0.1 gm / lit
  - Preferred concentration for precipitation: 20 gm / lit
  - Enrichment required: 200

- **Enrichment: normally in 2 - cycles**
  - 1\textsuperscript{st} cycle: 0.1 gm / lit to 1.5 gm / lit
  - 2\textsuperscript{nd} cycle: 1.5 gm / lit to 20 gm / lit

- **Product precipitation**

- **Product purification**
  - Before and after precipitation
Simplified Process Schematic

Pre / Post Treatment

1st Cycle

2nd Cycle

Product Precipitation & Filtration
Key areas needing attention for successful Commercialisation

- Developing awareness & co-ordination among all stakeholders

- Technology development addressing all challenges
  - commercially viable Technology
  - Institutionalization of Knowledge base (Life-cycle)

- Art of Technology Commercialization
  - Systematic Pre & Detailed feasibility studies (economic, social, environmental, policy)
  - Project Execution through proven Project Management techniques, timely execution & successful O & M

Seamless merger of these competencies hold the key
Important Pre-requisite: Stake-holder’s Engagement

- Phosphate Industry
- Nations / States
- Stock Holder
- Environment (Regulators)
- Technology Providers
- Utility Company
- Nuclear Community
- Society

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Proven model of activity life cycle through successive Development, Demonstration & Commercial Deployment.
Taking step forward in the right direction

Technology Development

- Clear understanding & expertise in all constituent activities, their sequence & timeframe
  - Initiation of experiments in Laboratory / Scaled up facility & collection of Data
  - Fine tuning Process Integration, Process optimisation & equipment selection during Pilot plant operation
  - Conversion of Data generated into Process Package
  - Basic Engineering & preliminary cost estimate
  - Systematic Pre-feasibility study

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Step forward in right direction

**Project Management**

- Knowledge on Industry established norms & Practices & Professional skill for systematic transition from one activity to the next
  - Detailed Engineering, Environmental impact assessment & Detailed cost estimate
  - Definitive feasibility Study
  - Project execution following established procurement / construction practices, Commissioning & subsequent successful Operation & Maintenance
Concurrent Activities in a Time-frame

- Research
- Development
- Demonstration
- Formulation
- Execution

Time in months:

0 9 18 27 36 45 56 64

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Taking a Call... for better tomorrow

- Uranium extraction from Phosphate offer excellent opportunity for society & environment.
- Challenges to be overcome by following time tested project activity lifecycle & Co-operation of all stake holders.
- Nuclear community cannot afford wastage of energy resource.
- Responsive nations to formulate pragmatic policy in recognition to the social return
- This will be our gift to society & the ‘generation next’
Thank you

For Your Attention