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

	2014	2050
• World Population	7.2 billions	9.6 billions
• No access to Electricity	2 billion	?
• No access to safe & reliable water	768 million	? (demand 55% higher)
• No access to sanitation	2.5 billion	?
• Food Demand	2.2 billion tonnes	3 billion tonnes

We all love Peace ....

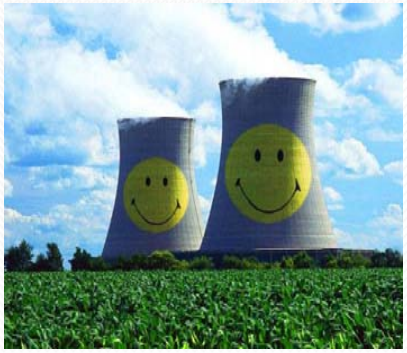
Must ensure basic minimum needs of society worldwide is met !

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

Mine

Acid Plant

Fertiliser Plant

U-Recovery Plant

- 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**

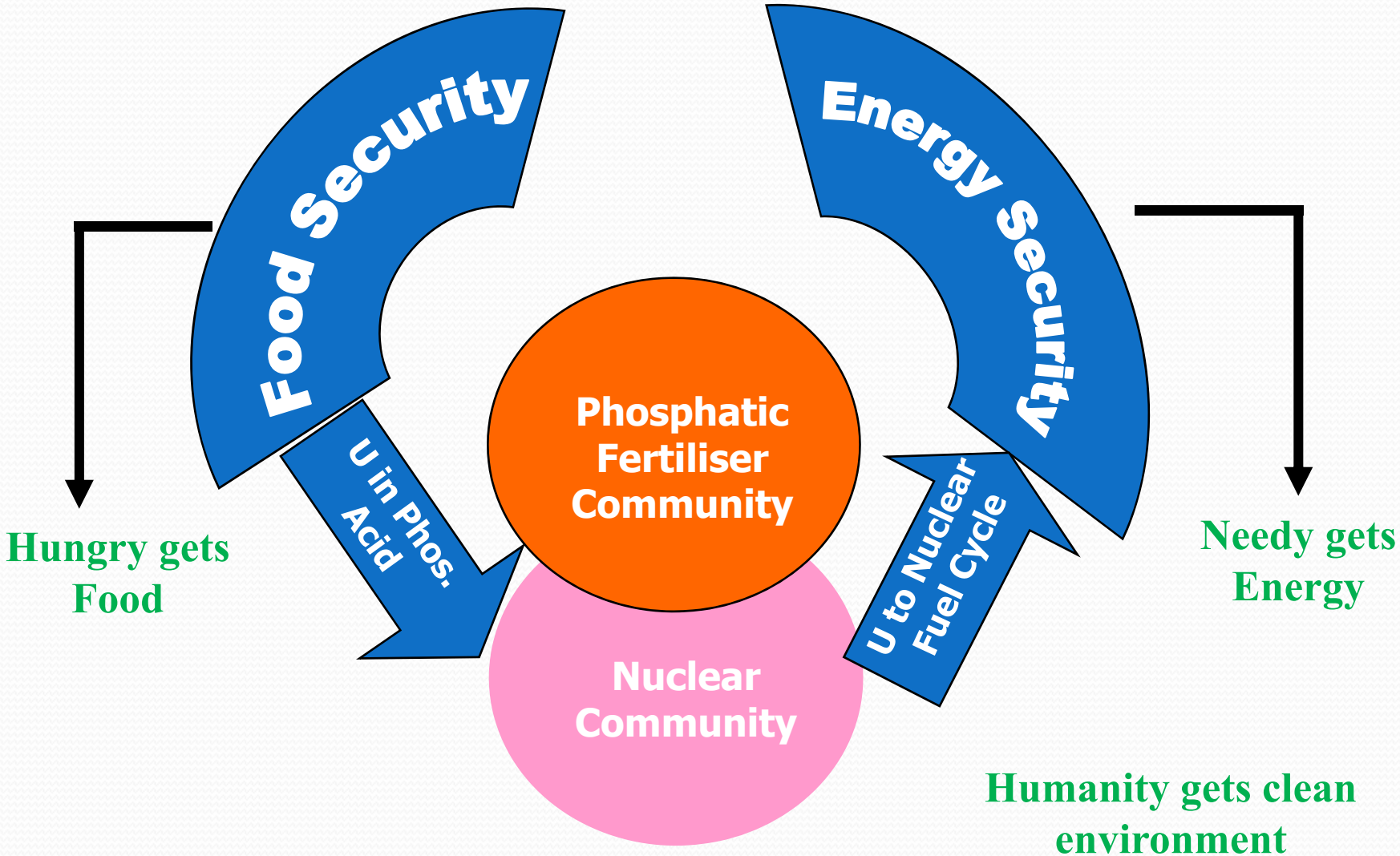
Socio-economic attraction

- 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



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

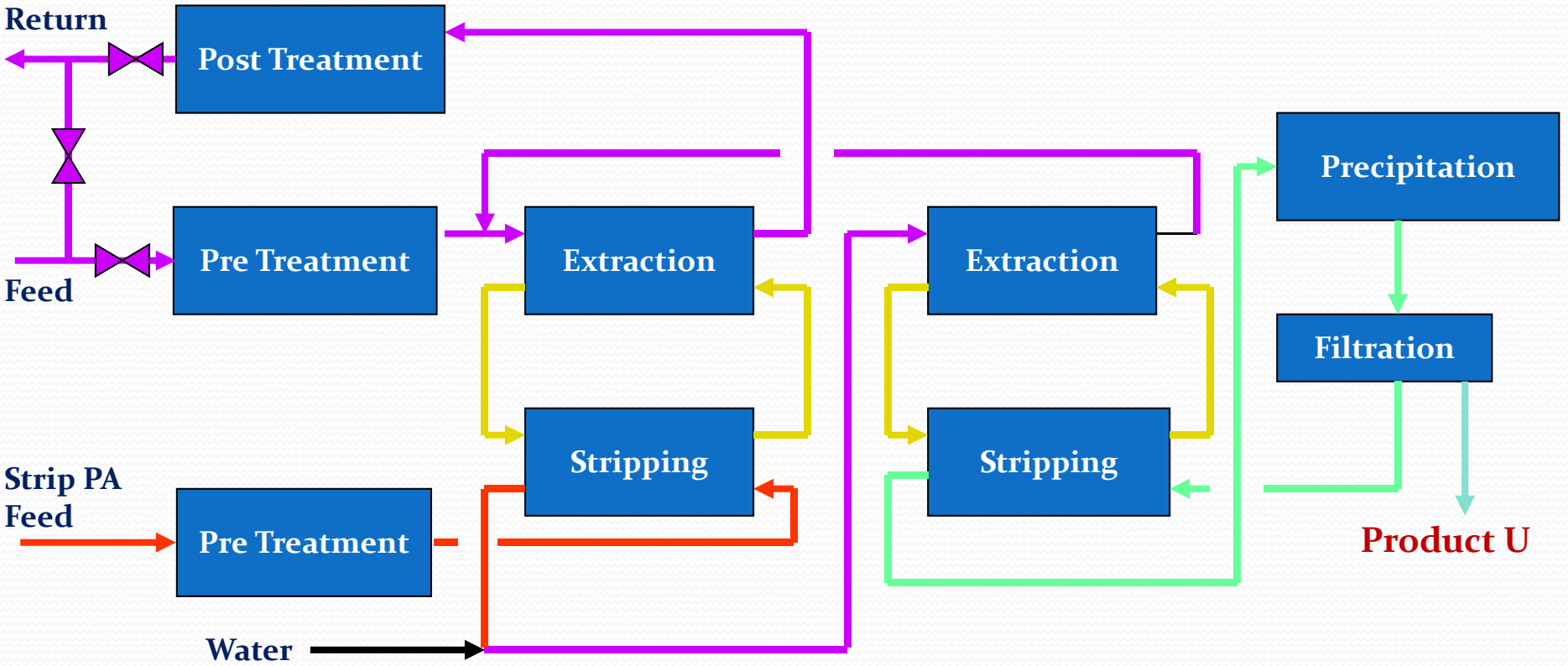
	SX (Liquid – Liquid)	IX (Solid – Liquid)
• Process / Equipment	Conventional, Proven, Flexible, Simple	Performance, Kinetics, Relative cost (?)
• Safety / Environment	Fire	Waste Disposal
• CAPEX / OPEX	High	Reported to be low
• Industry experience	Proven	Yet to be demonstrated
• Life-cycle performance	Data Available	Yet to be demonstrated

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^{st} cycle : 0.1 gm / lit to 1.5 gm / lit**
  - **2^{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

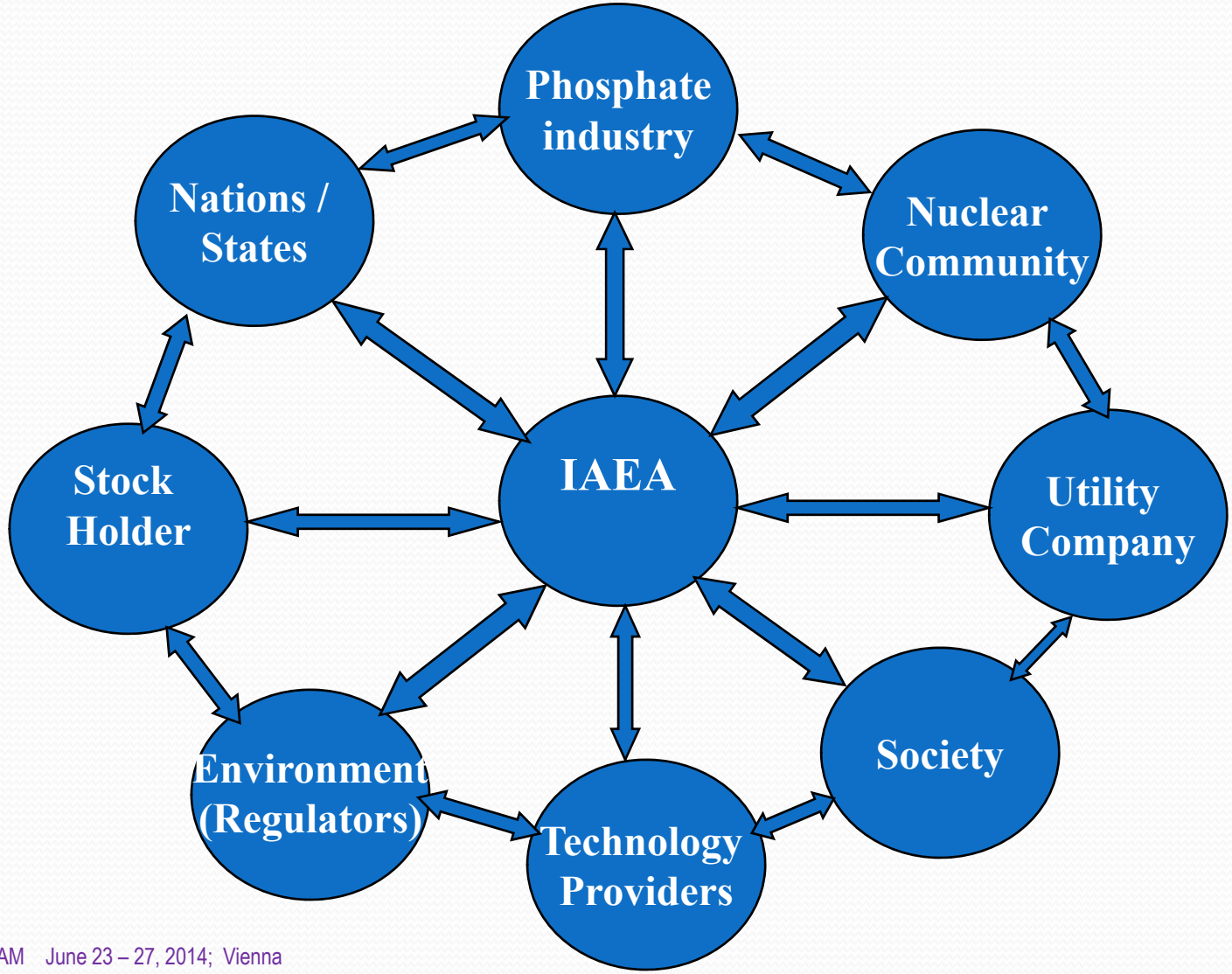
Product Precipitation & Filtration

Key areas needing attention for successful Commercialisation

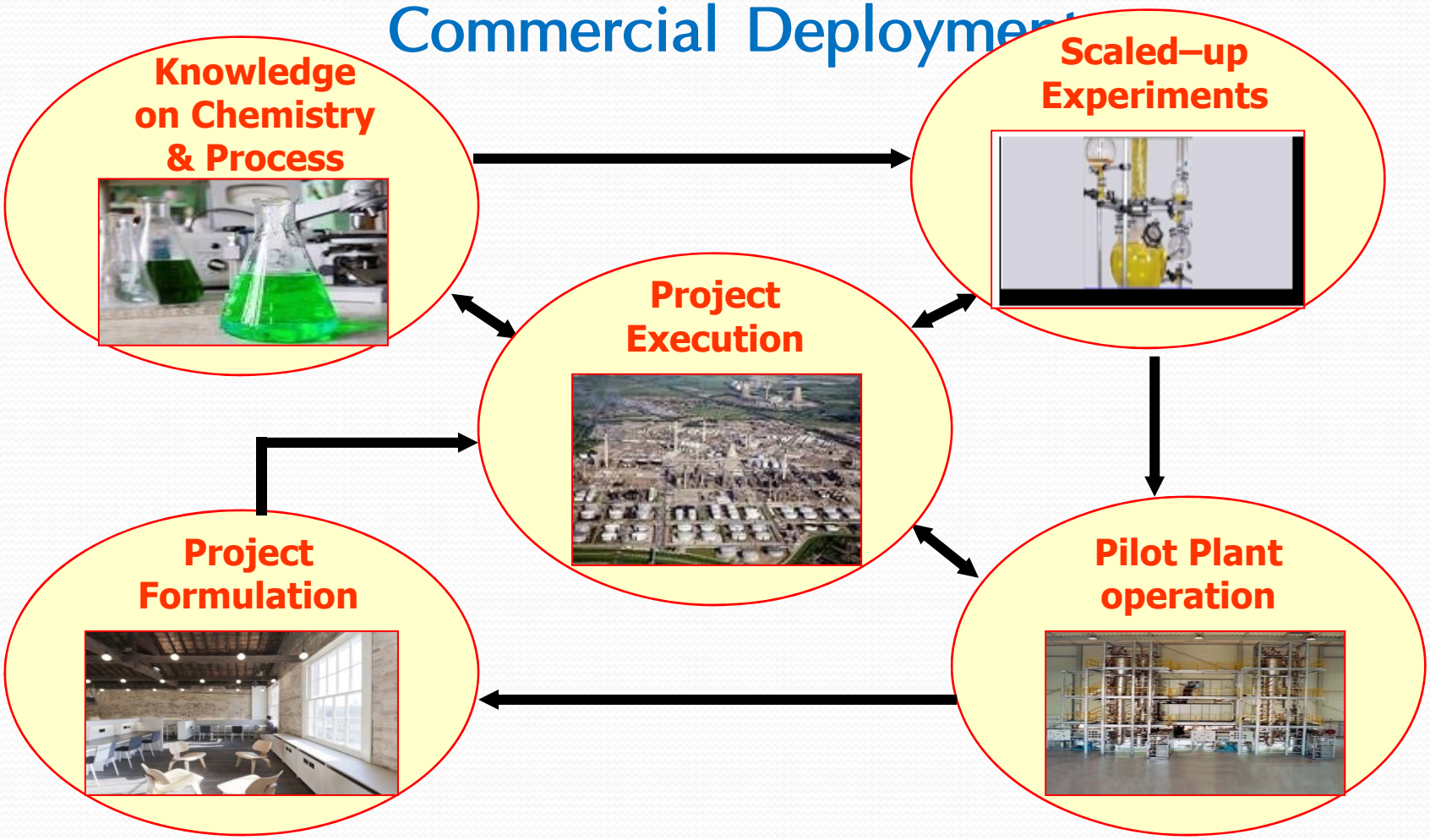
- Developing awareness & co-ordination among all stake holders
- Technology development addressing all challenges
  - commercially viable Technology
  - Institutionalization of Knowledge base (Life-cycle)
- Art of Technology Commercialization
  - Systematic Pre & Detailed feasibility studies (economic, 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



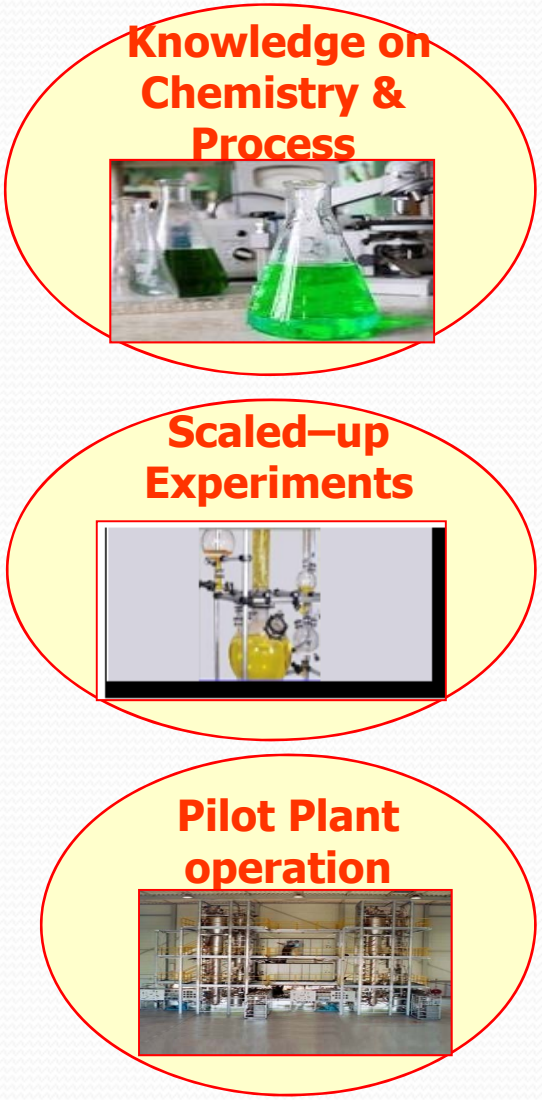
Proven model of activity life cycle through successive Development, Demonstration & Commercial Deployment



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



Step forward in right direction

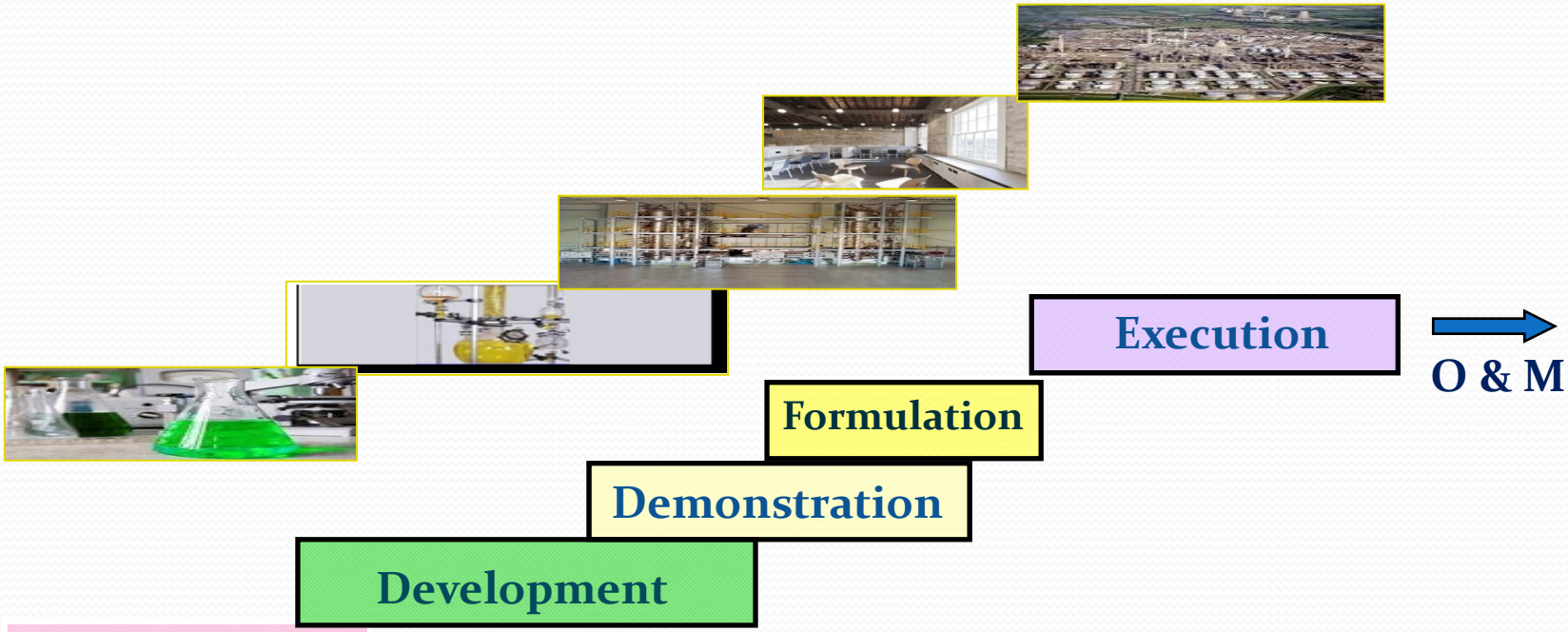
Project Management

- 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

Project Formulation

Project Execution

Concurrent Activities in a Time-frame



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
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