
Considerations of NES in Jordan

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Regional Cooperation on the Way to Sustainable NES*

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Jordan Atomic Energy Commission



Jordan Country Profile



- Total Area: 89 213 sq. Km

- Sea Port: Aqaba

- Coastline: 26 Km

- Population: 5.96 million

31% (15- 29) 38% (below 15)

- Climate: Mediterranean & Arid Desert

- GDP: \$21.5 billion

- Per Capita: \$3,554

- Annual GDP Growth: 7% (2000-2009)

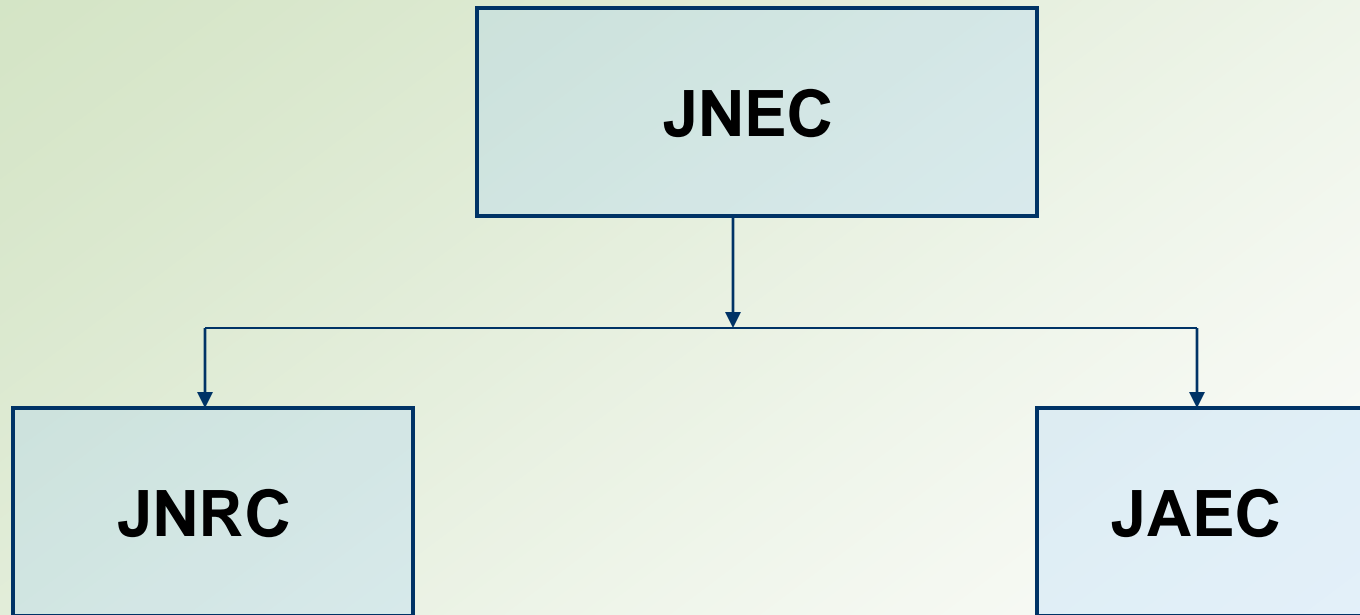
Status of Implementing Nuclear Power in Jordan

- Established key bodies:
 - Nuclear Regulator – JNRC
 - Nuclear Procurement Agency - JAEC
- Building the Infrastructure
 - Sites
 - Laws and regulations
 - Education
 - International Collaboration – IAEA, Peer Groups, Collaboration Agreements
- Technology Selection
 - Detailed process using IAEA methodology and supported by experienced advisors
 - Shortlisted two technologies for final negotiations
- Identification of operator/investor partner



Reorganization of the Nuclear Authorities

The Nuclear Law was modified in 2007 to allow the creation of two independent commissions: Jordan Atomic Energy Commission (JAEC) and Jordan Nuclear Regulatory Commission (JNRC)



High Nuclear Ministerial Steering Committee

- Chaired by PM
- Established Dec. 2009
- Members: Ministers of
 - Ministry of Energy
 - Ministry of Foreign Affairs
 - Ministry of Water
 - Ministry of Public Works
 - Ministry of Environment
 - Ministry of Mega-Projects
 - Ministry of Planning
 - Ministry of Finance
 - Chairman of JAEC
 - Vice Chairman, JAEC
 - DG, JNRC



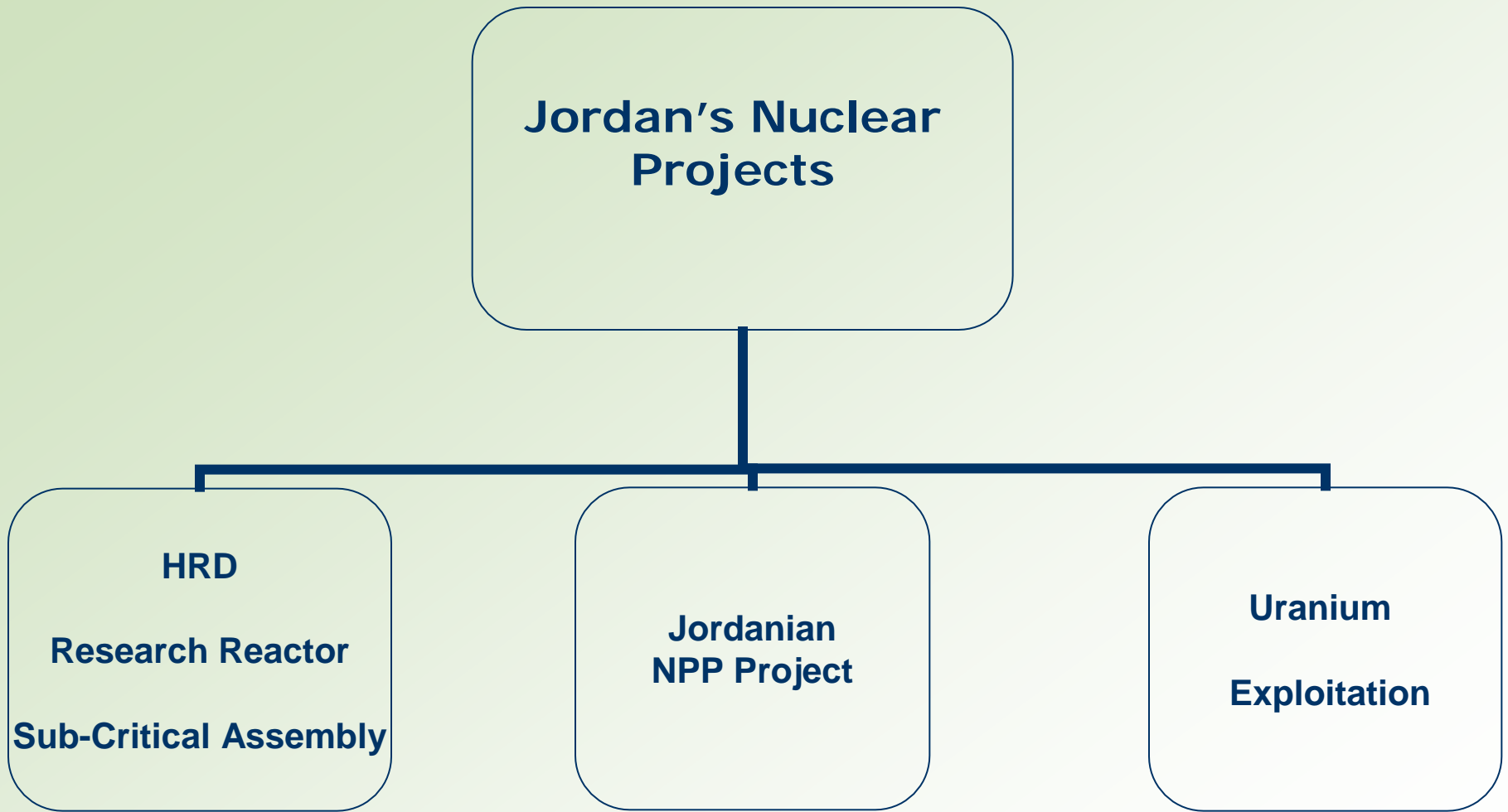
Conventions and Agreements

	In Force	Status
Agreement on the Privileges and Immunities of the IAEA	1982-10-27	Acceptance: 1982-01-27
Convention on Early Notification of a Nuclear Accident	1988-01-11	Signature: 1986-10-02 Ratification: 1987-12-11
Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency	1988-01-11	Signature: 1986-10-02 Ratification: 1987-12-11
<i>Convention on Nuclear Safety</i>	2009-09-10	Signature: 1994-12-06
Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA)	1989-02-05	Signature: 1974-12-05
Co-operative Agreement for Arab States in Asia for Research Development and Training Related to Nuclear Science and Technology (ARASIA)	2002-08-20	Acceptance: 2002-08-20
Convention on the Physical Protection of Nuclear Material	2009-10-07	Accession : 2009-09-07

Conventions and Agreements (2)

	In Force	Status
Application of Safeguards in connection with the Treaty on Non-Proliferation of Nuclear Weapons (with protocol)	1978-02-21	Signature: 1974-12-05
Protocol Additional to the Agreement between the Hashemite Kingdom of Jordan and the IAEA for the Application of Safeguards in Connection with the Treaty on Non-proliferation of Nuclear Weapons	1998-07-28	Signature: 1998-07-28
Comprehensive Test Ban Treaty.		Signature: 1996-09-26 Ratification:1998-08-25

Current Activities



Vendor & Strategic Selection

- JAEC elected to arrive at a design/vendor selection process for construction of the first nuclear power plant through an engineering, procurement and construction project.
- It is intended that the plant will consist of a Generation 3 or 3+ unit with an option for second unit with a capacity ranging from 700 to 1,200 MWe per unit.

Selection of Strategic Partner

- In addition to a safe & licensable technology, Jordan also needs a strong partner that will address challenges:
 - Equity, financing, leadership, and management
 - Safe operating capability
 - Maximize economic value for Jordan
 - Assist in HRD



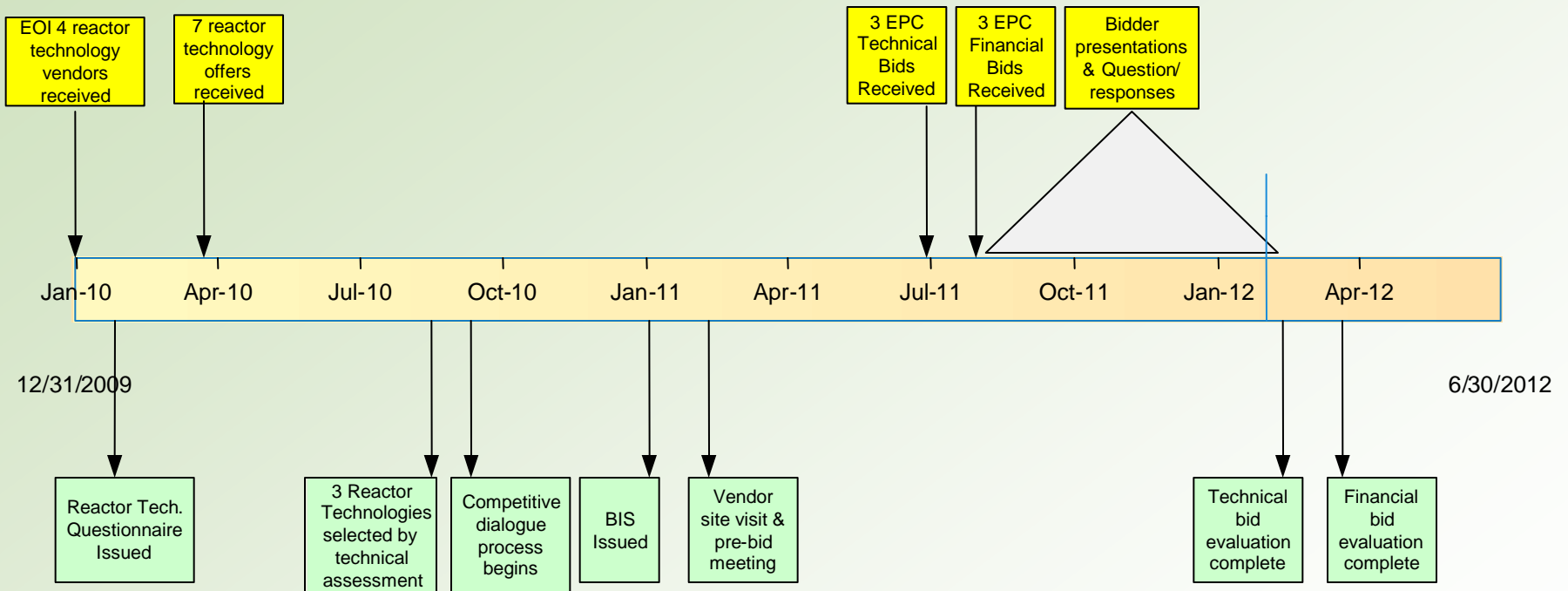
Technology Selection

- Exclusionary Topics
- Assessment of the vendor technology towards Key Factors (important for Jordan)
- Evaluation Matrix
- Best-in-Class for each evaluation criteria
- Price under competitive environment



Timeline

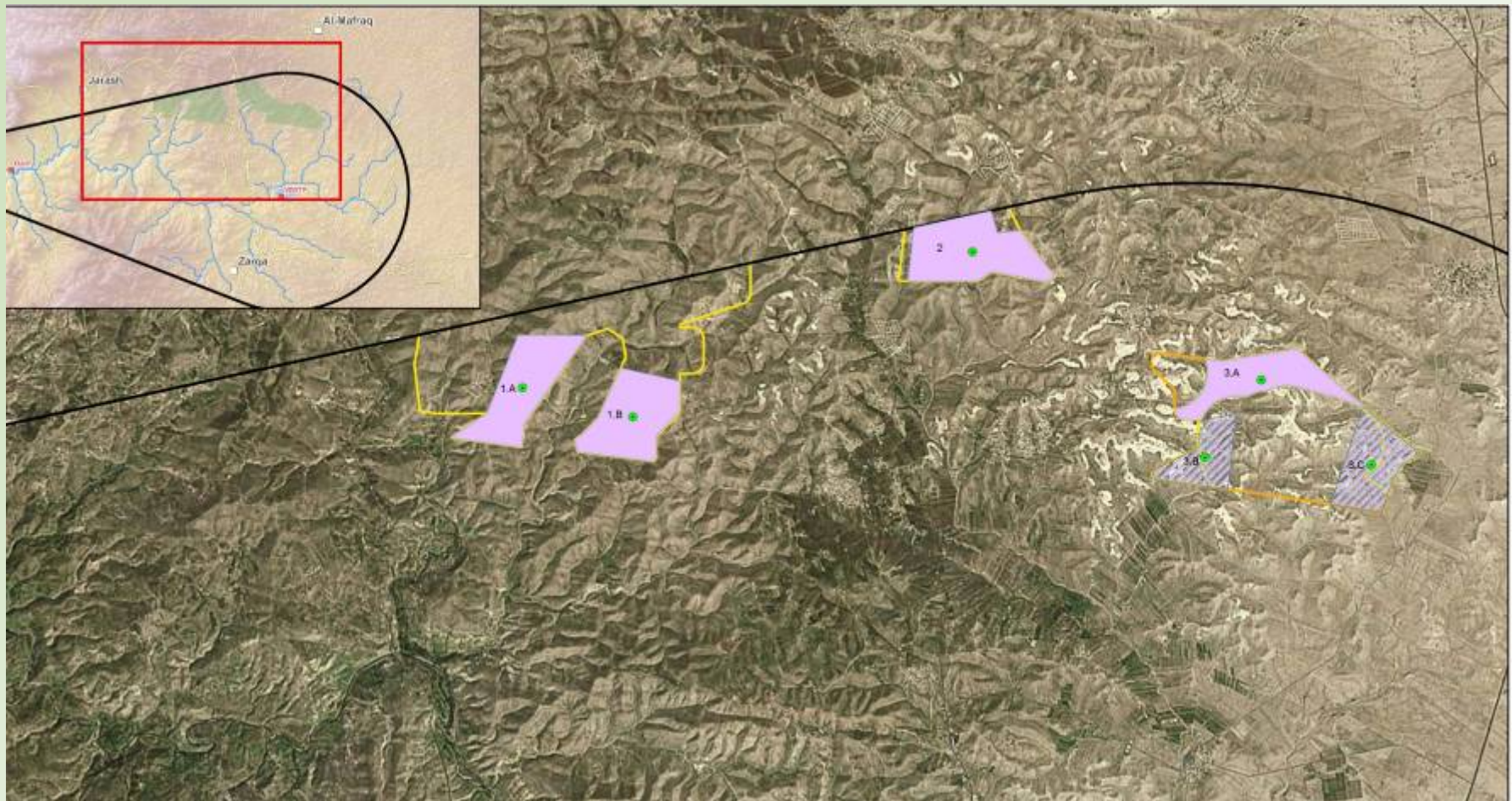
Technology Selection Key Events



Assamra Region of Interest



Site Selection- 6 Candidate Sites



Education

- Jordan University of Science and Technology
 - established a nuclear engineering dept. to graduate future reactor operators holding B.Sc. degrees in nuclear engineering
- JU, YU, BAU have started M.Sc. programs in nuclear physics & students are trained on the Van de Graaf & SESAME

Nuclear Research Facilities

Jordan Research and Training Reactor (JRTR)

- Training Center
- PSAR submitted to JNRC on July 31, 2011
- Nuclear construction is planned to start in Dec. 2012

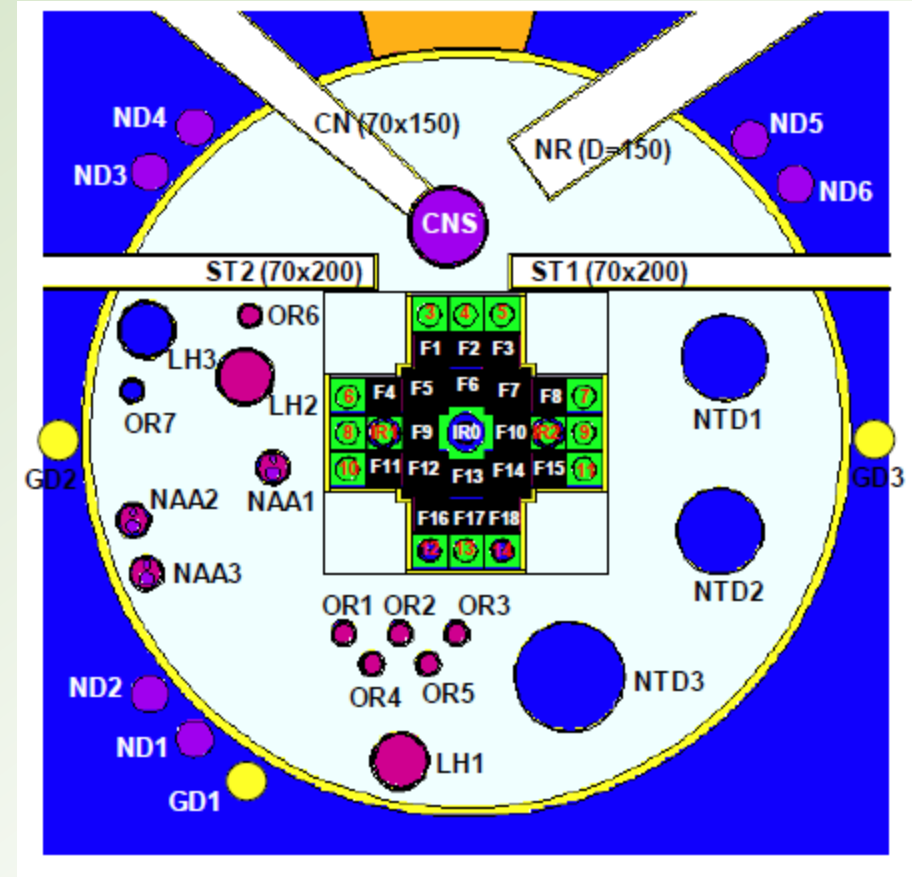
Subcritical Assembly

- Completely assembled on site
- Ready to be commissioned
- Operation and staffing issues are under the auspices of JUST



JRTR Overview

- 5-MW upgradeable to 10-MW
- Open pool
- MTR, plate type fuel (20% enriched in U-235)
- H₂O cooled
- D₂O + Be reflected

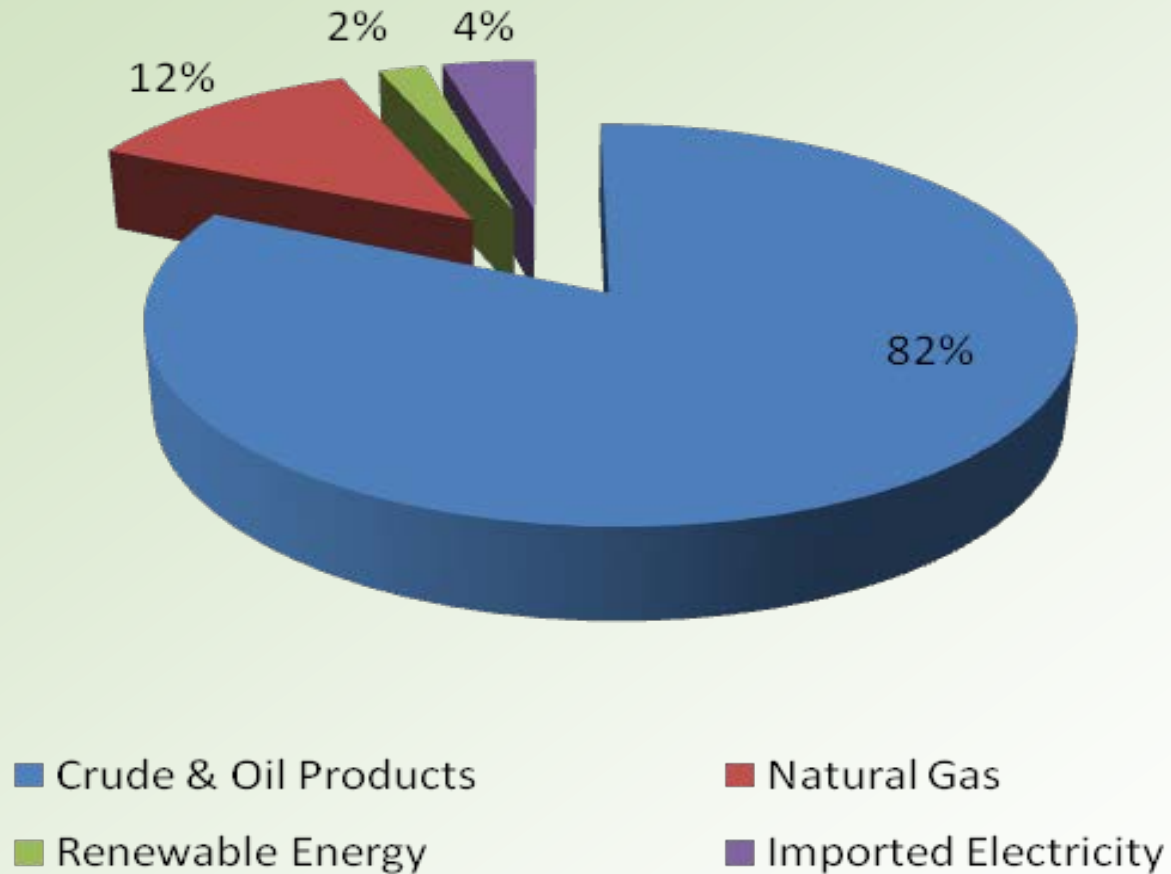


Jordan's Nuclear Power Programme – Drivers

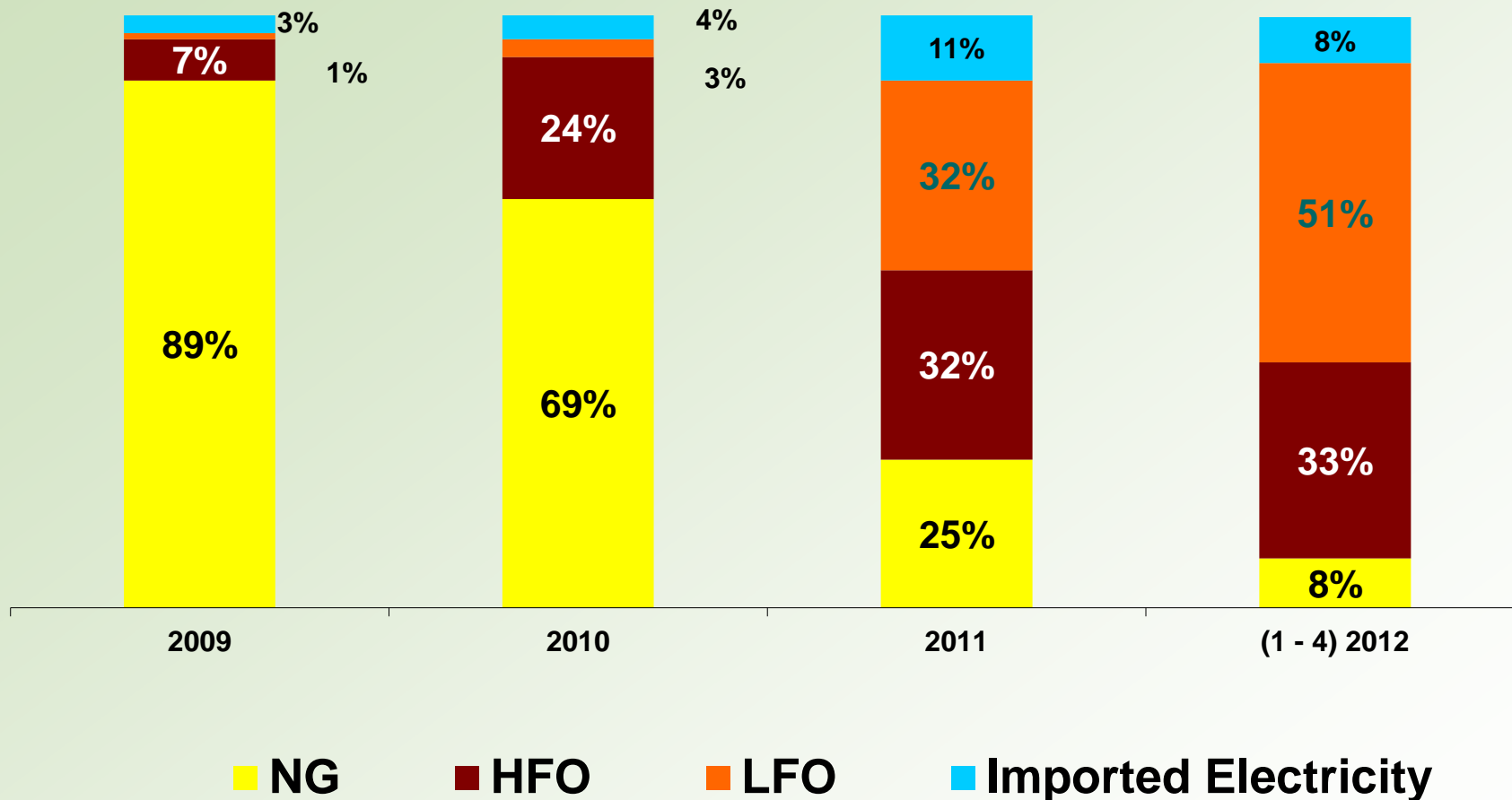
- Security of supply
- Growing demand for energy
 - electricity
 - desalination
- Need for Baseload power
- Diversification away from hydrocarbons
 - high and volatile prices
- Lack of indigenous fuel options



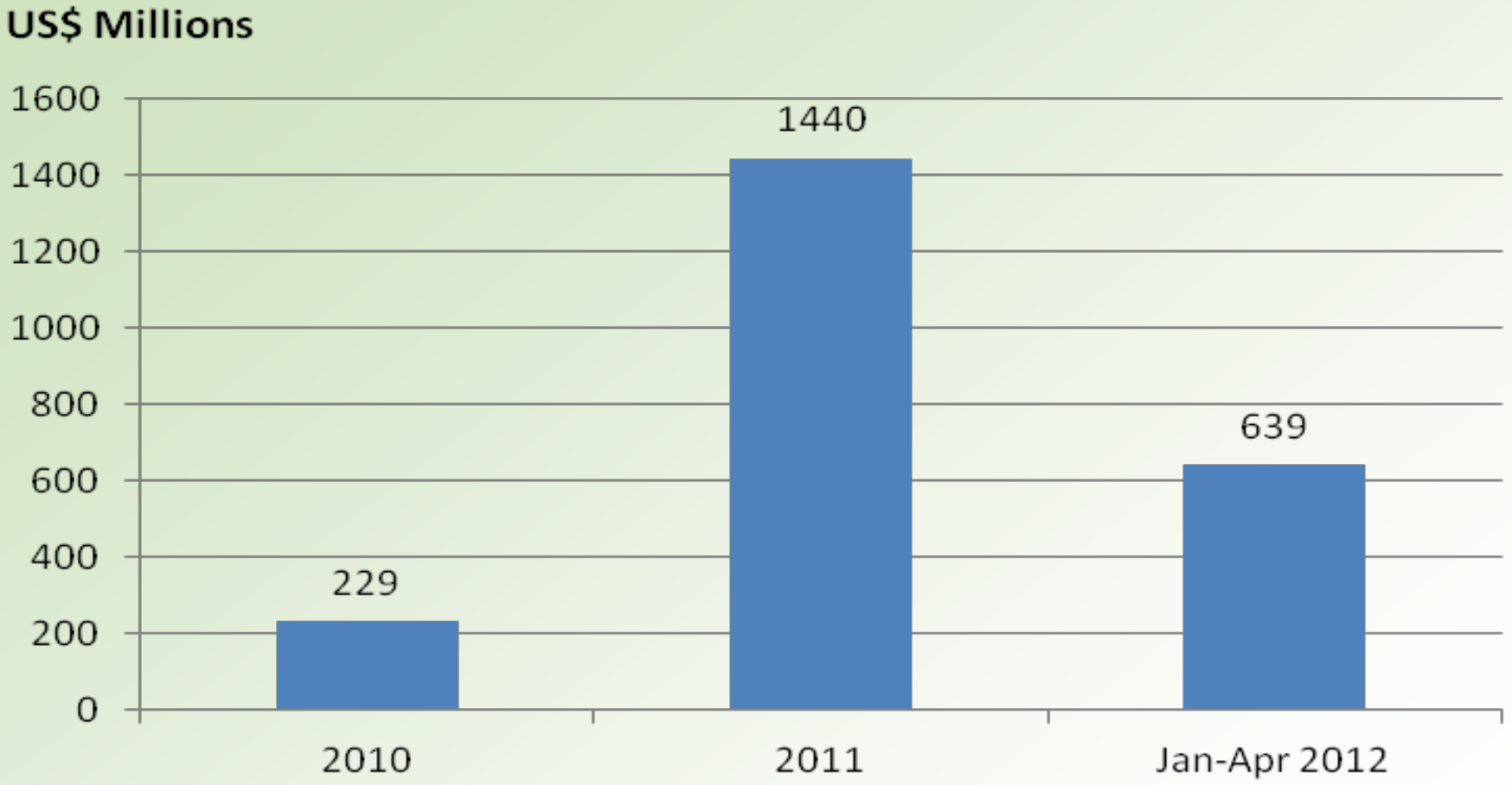
Energy Mix - 2011



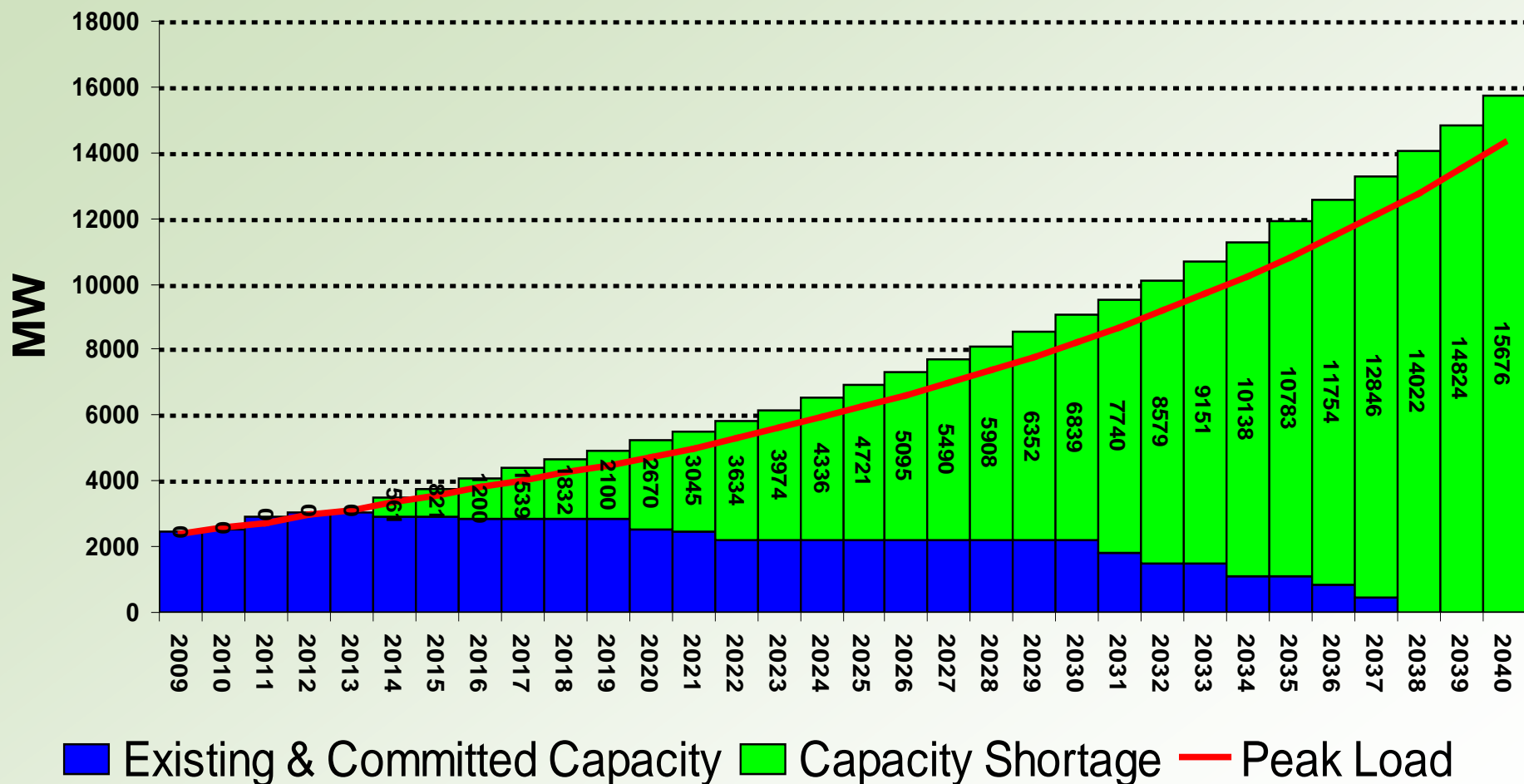
Electricity Generated by Fuel Type



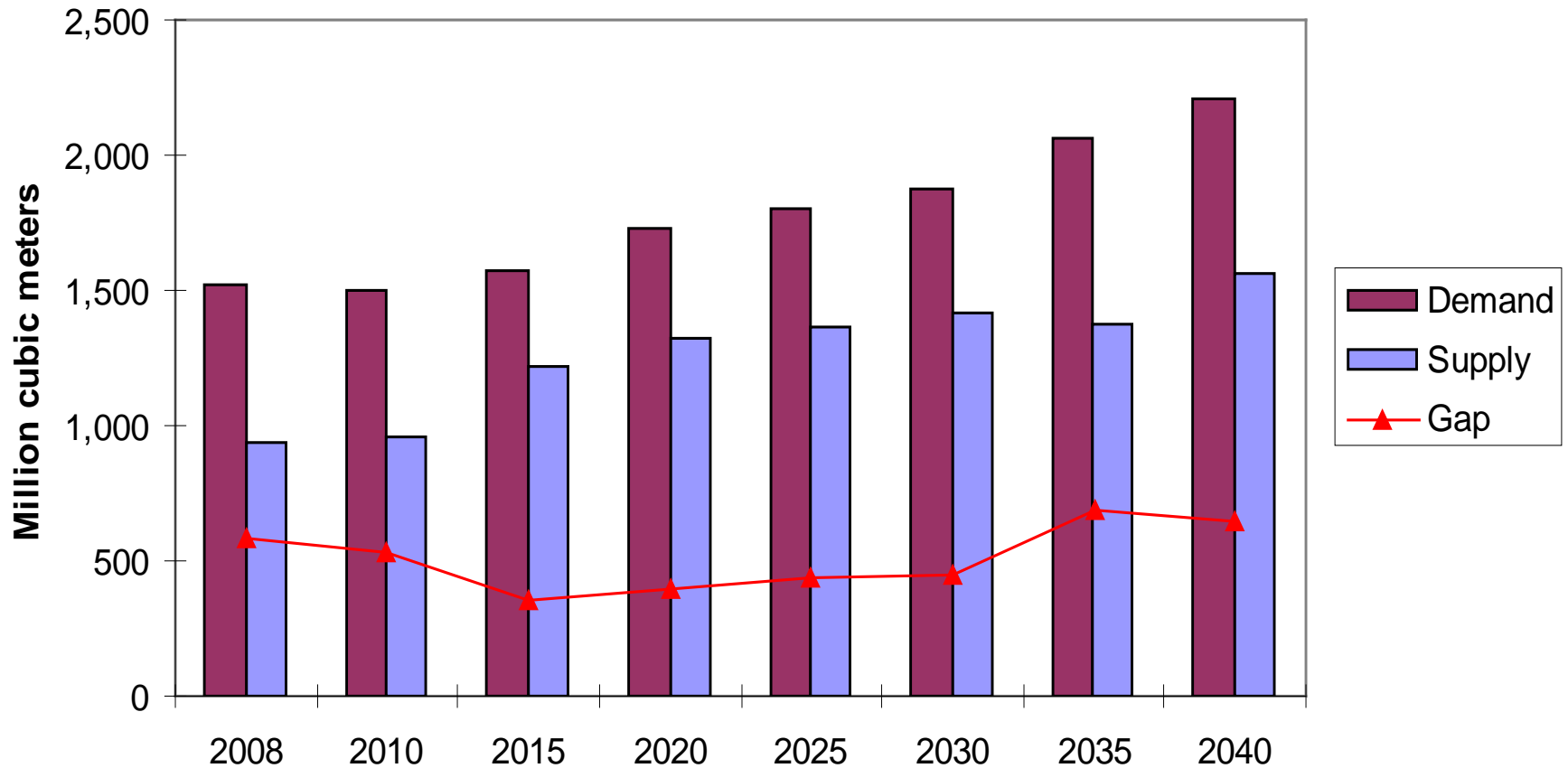
Direct Losses Due to Natural Gas Interruptions



Available and Committed Capacities versus the Electricity Median Load Forecast



Water Situation in Jordan



Anticipated Benefits

Project Background

- 99% of Jordan's electricity is generated from **either oil or gas, which is in turn 96% imported**
- 6800 MW of new power generating capacity **needed to satisfy the demand by 2030**
- Decision has been reached to **build a new Nuclear Power Plant**

Project Benefits

- Increase **energy independence**,
- Provide electricity to the country at a **reasonable price**,
- **Ensure additional income** and balancing loads by exporting electricity to the neighboring countries (Egypt, Saudi Arabia, Iraq, Syria and Palestine),
- Utilize/ Leverage **domestic uranium reserves**,
- Provide opportunity to **develop nuclear capabilities**, including participation in project development, design, construction, and plant operation,
- **Multiplicative effect on local economy** via infrastructure upgrades, job creation, provision of services, and education of workforce,
- **Reduce CO2 emissions**, by switching to minimum CO2-intensive electricity production
- **Support major infrastructure projects**, such as Red Sea – Dead Sea Canal project

JRTR

- The research and training reactor would serve as an integral part of the nuclear technology infrastructure.
- It will become the focal point for a Nuclear Science and Technology Center (NSTC).
- Play the primary role in educating and training the upcoming generations of nuclear engineers and scientists.
- Provide irradiation services in support of the Jordanian industrial, agricultural and health/medical infrastructure.

Impediments

- Several challenges need to be addressed in order to develop Jordan's nuclear energy programme:
 1. Regional political turmoil
 2. Political acceptance
 3. Water requirements for cooling
 4. Funding
 5. Human resources development
 6. Grid size
 7. Transportation of equipment
 8. FOAK
 9. Waste management



Public Reaction



Financing Challenges for Jordan in Particular

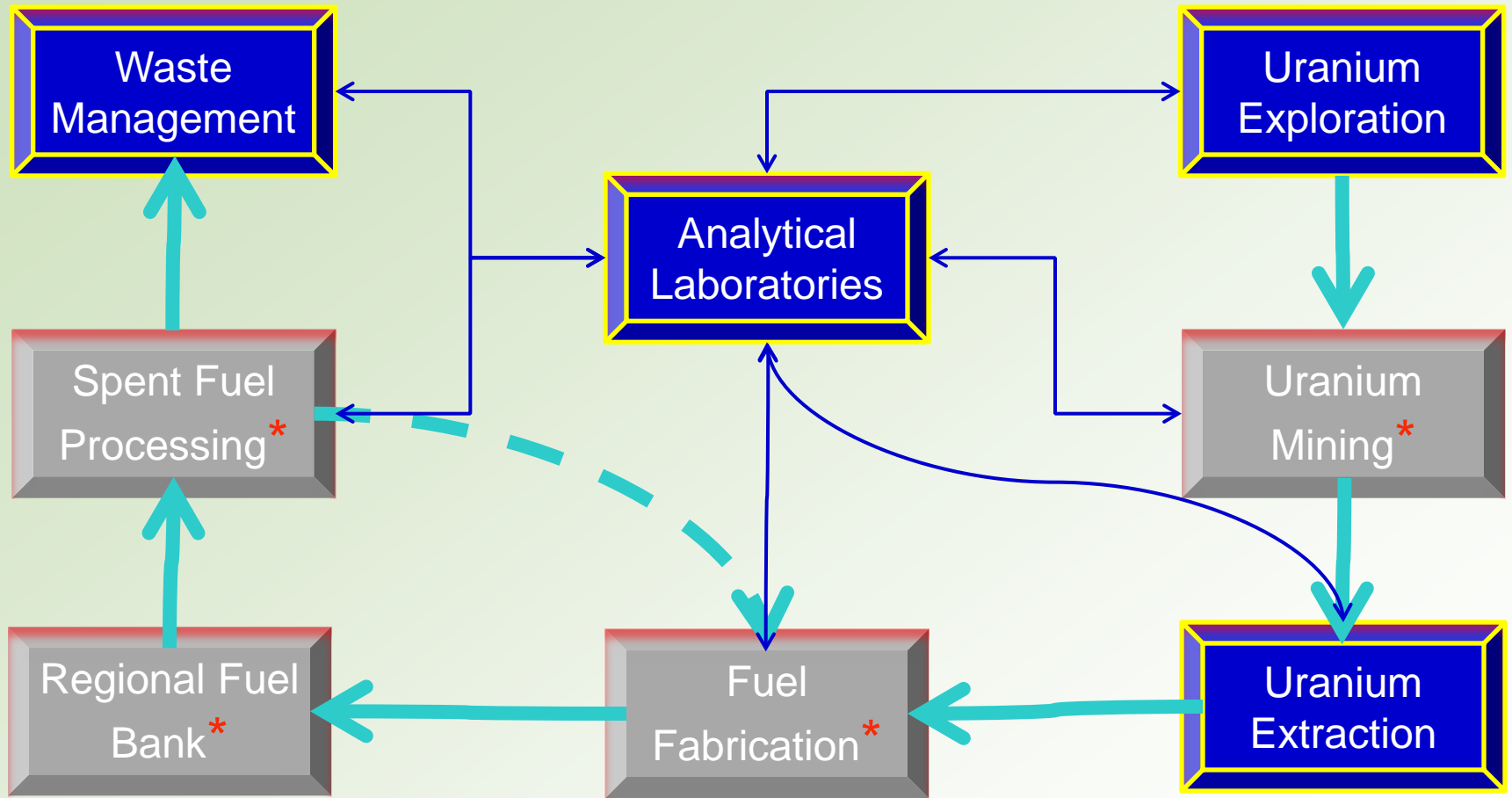
- Scale of the investment relative to Jordan's GDP
- Limited Government financing available – not like many other Arab Countries
- Jordan's credit rating and IMF restrictions are hurdles for financing and ability to provide sovereign guarantees (which are likely to be required)
- First nuclear power plant – no track record of construction or operation
- Regional issues

NES in Jordan

- Jordan is eager to develop capabilities and assets to be nuclear energy regional centre of excellence by 2030-50
- By 2030, at least 2000 MWe of PWR, about 25% of installed capacity
- By 2050, 2000-3000 MWe of additional nuclear capacity (GIII+, SMR, HTR)



JAEC's Nuclear Fuel Cycle Activities



* Future Projects



NES in Jordan (2)

- Services (under bilateral or multilateral auspices)
 - Mining and milling
 - Conversion
 - Enrichment
 - Fuel assembly manufacturing
 - Fuel treatment

- Criteria
 - Expansion of NP in the Middle East
 - Political stability
 - Economic considerations
 - Regional collaboration
 - Public acceptability

Local Participation

- In the Short-term, 20-30% of local participation
 - Construction
 - Mining and conversion
 - O&M
- In the Long-term, up to 50%
 - Construction
 - O&M
 - Mining and conversion
 - Enrichment
 - Fuel manufacturing
 - Specialized components

Back-end Fuel Services

- In the Short-term
 - Store spent fuel on site
- In the Medium-term
 - Conduct economic analysis of disposition options

- Long-term

Four Options

- (1) Treat spent fuel and store regionally
- (2) Return spent fuel for good
- (3) Return spent fuel and get back HLW
- (4) Dispose of spent fuel in national repository

Sustainable Nuclear Energy System

- Jordan participates in IFNEC & INPRO to develop collaborative approaches to sustainable NES

Priority Areas

Regional collaboration

Economics

Safety & Security

Waste management

Proliferation resistance



Energy Independence & Security of Supply

- Very few countries can be truly “Energy Independent”
- Jordan is trying to decrease its energy supply vulnerabilities
 - By investing in local energy resources
 - By diversifying imported supplies
 - By investing in human resources and creating energy services
 - By increasing security of its supplies



Enabling & Inhibiting Factors for Security of Supply

Enabling

- **National uranium resources**
- **Secure long fuel supply agreement**
- **JV-Strong international partner with investment in the plant**
- **National or regional manufacturing for critical spare parts**
- **Development of regional fuel cycle services**

Inhibiting

- **Monopoly of reactor supply**
- **Monopoly of fuel supply**

Regional & Global cooperation and collaboration could strengthen the notion of Security of Supply

Nuclear Cooperation

- Signed NCA with France, China, Russia, UK, South Korea, Canada , Argentina, Spain, Japan, Romania, Italy, and Turkey.
- Signed MoU with Kuwait & USA
- Negotiating MoU with Egypt & Indonesia
- Ongoing negotiations with USA, and Czech Rep., Ukraine, and Armenia

GNEP

Jordan signed the Statement of Principles of GNEP on Sep. 16, 2007 as the first Middle Eastern country



IFNEC 2010

Jordan hosted the first Ministerial Meeting and first Steering Committee meeting of the International Framework for Nuclear Energy Cooperation (IFNEC) in November 2010



IFNEC Vision Statement

The International Framework for Nuclear Energy Cooperation provides a forum for cooperation among participating states to explore mutually beneficial approaches to ensure the use of nuclear energy for peaceful purposes proceeds in a manner that is efficient and meets the highest standards of security, safety and non-proliferation. Participating states would not give up any rights and voluntarily engage to share the effort and gain the benefits of economical, peaceful nuclear energy.



Examples of Cooperation

- JV with Areva in Uranium exploitation
- Subcritical assembly (China)
- JRTR (South Korea): Project management, Licensing support
- HRD (France, China, Russia, USA, South Korea)
- A Centre of Excellence for training nuclear engineers, managers and technicians was established in cooperation with France.

Drivers for Cooperation

- Share experiences, resources and costs
- Share regulatory staff and TSO
- Allow for economy of scale
- Accelerate project implementation
- Enhance negotiation position with technology vendors



Impediments for Cooperation

- National pride and “do it first alone”
- Political instability
- Differences in national legislations



Questions???

