Jordan's Energy Profile:
In Transition

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Jordan's Country Profile

- Total Area: 89,213 Km^2

- Sea Port: Aqaba

- Coastline: 26 Km

- Population: 9.456 million (2016)*
  60% (15- 64)
  35% (below 15)

- Climate: Mediterranean & Arid Desert

- GDP: $38.65 billion (2016)*

- Per Capita: $4,087 (2016)*

- GDP Growth: 2.0% (2016)*

- GDP Growth: 2.6% [f] (2017-2019)*

* WORLD BANK
[f] WORLD BANK - Forecasted

Jordan’s Energy Challenge

- Growing demand for energy
  - Primary energy
  - Electricity
  - Desalination

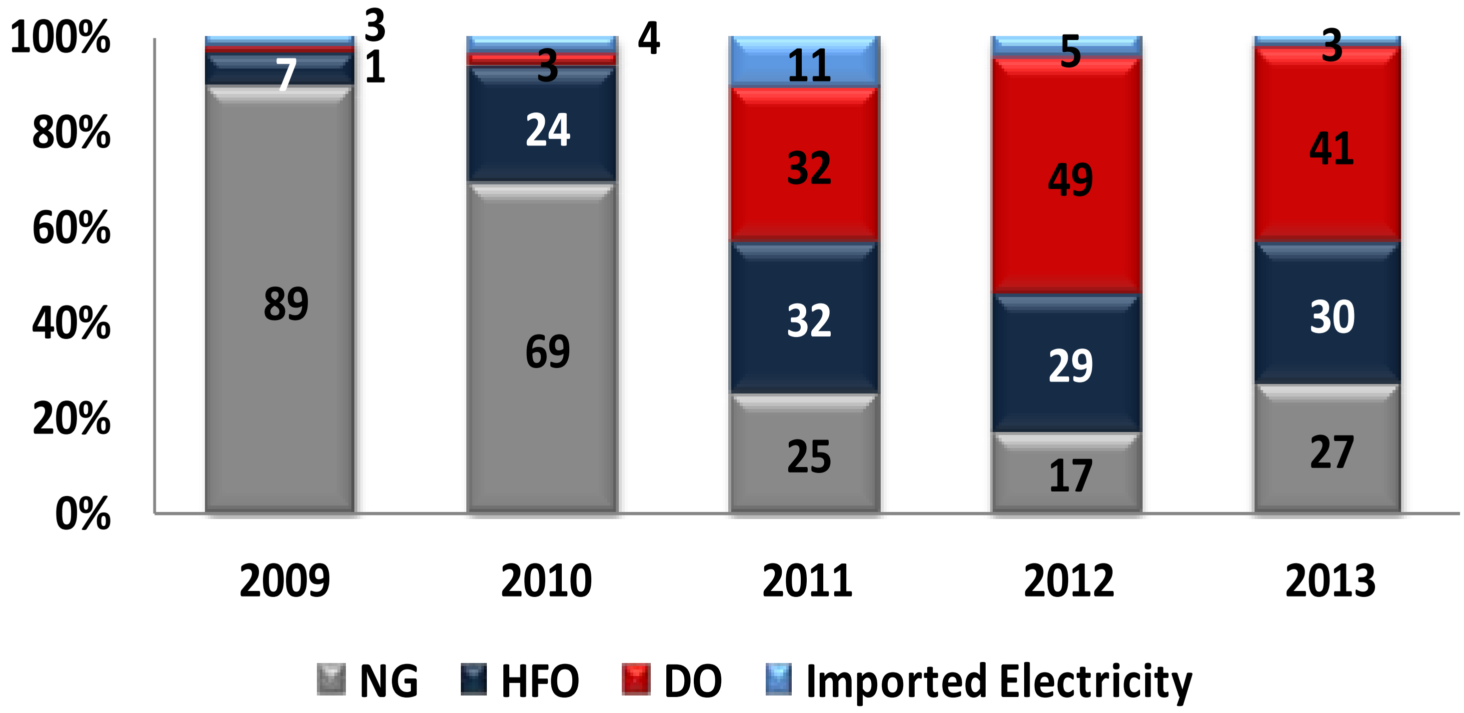
- Need for reliable and affordable base load power

- High dependency on imported fuels
  - High and volatile prices
  - Insecurity of supply

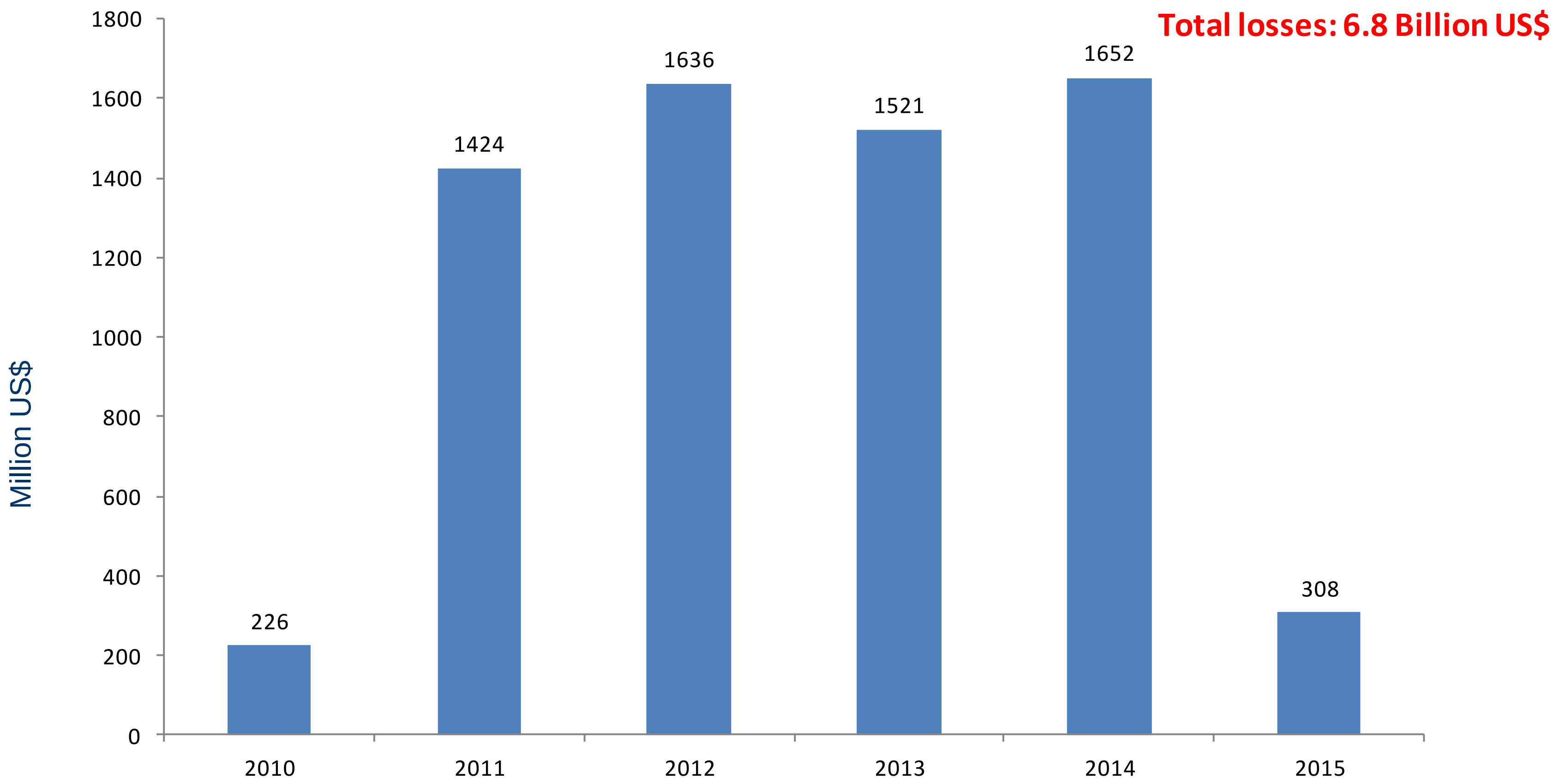
- Lack of indigenous conventional fuel options

Jordan's Power System

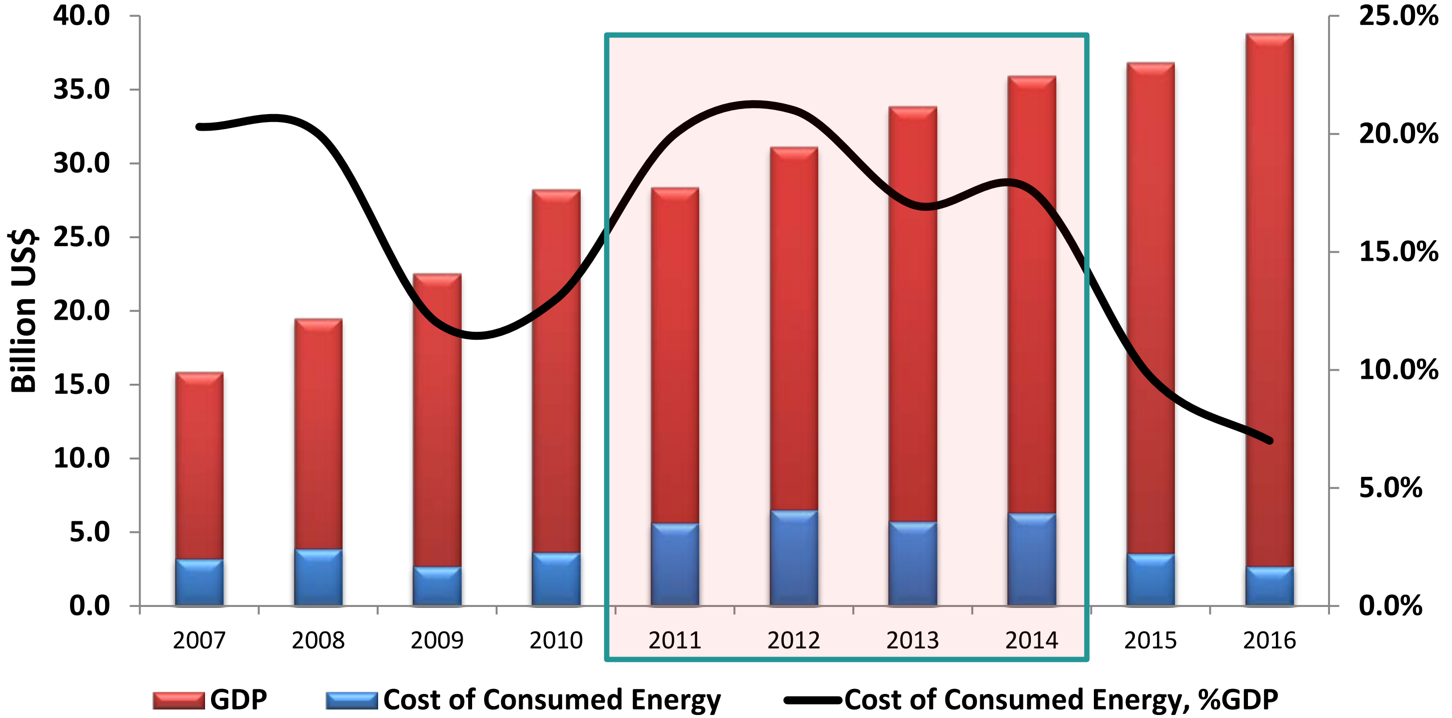
Electricity generation by fuel type:



Direct Losses due to Natural Gas Interruptions



Cost of Consumed Energy



Key Figures for Jordan’s Energy Sector (2016)

Cost of consumed energy (7.0% of GDP)

Annual growth of electricity demand (2.5%)

High dependency on imported energy (95%)

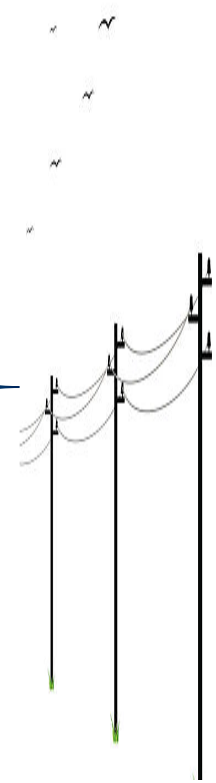
Annual growth of primary energy demand (7.0%)

Total Electricity Generation: 19730 GWh

Renewables Contribution to Installed Capacity: 13%

Total Electricity Consumption: 16843 GWh

Renewables Contribution to Gen. Electricity: 5.44%



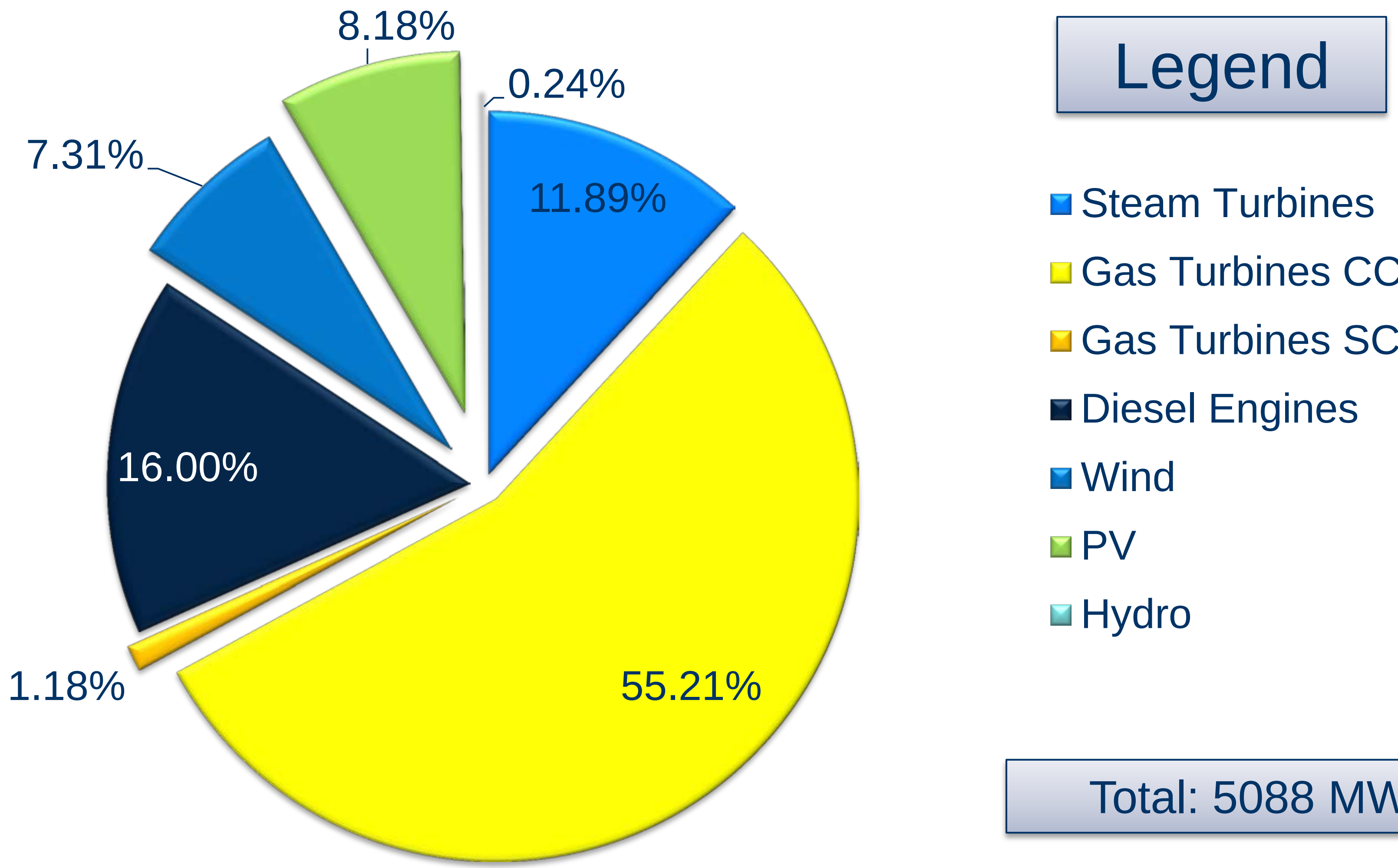
Installed Capacity (Conventional): 3800 MW

Installed Capacity (Renewable): 544 MW

Peak Load: 3250 MW

Per Capita Electricity Consumption: 1719 KWh

Generating Plants Capacity [MWe] 2018



Total: 5088 MW

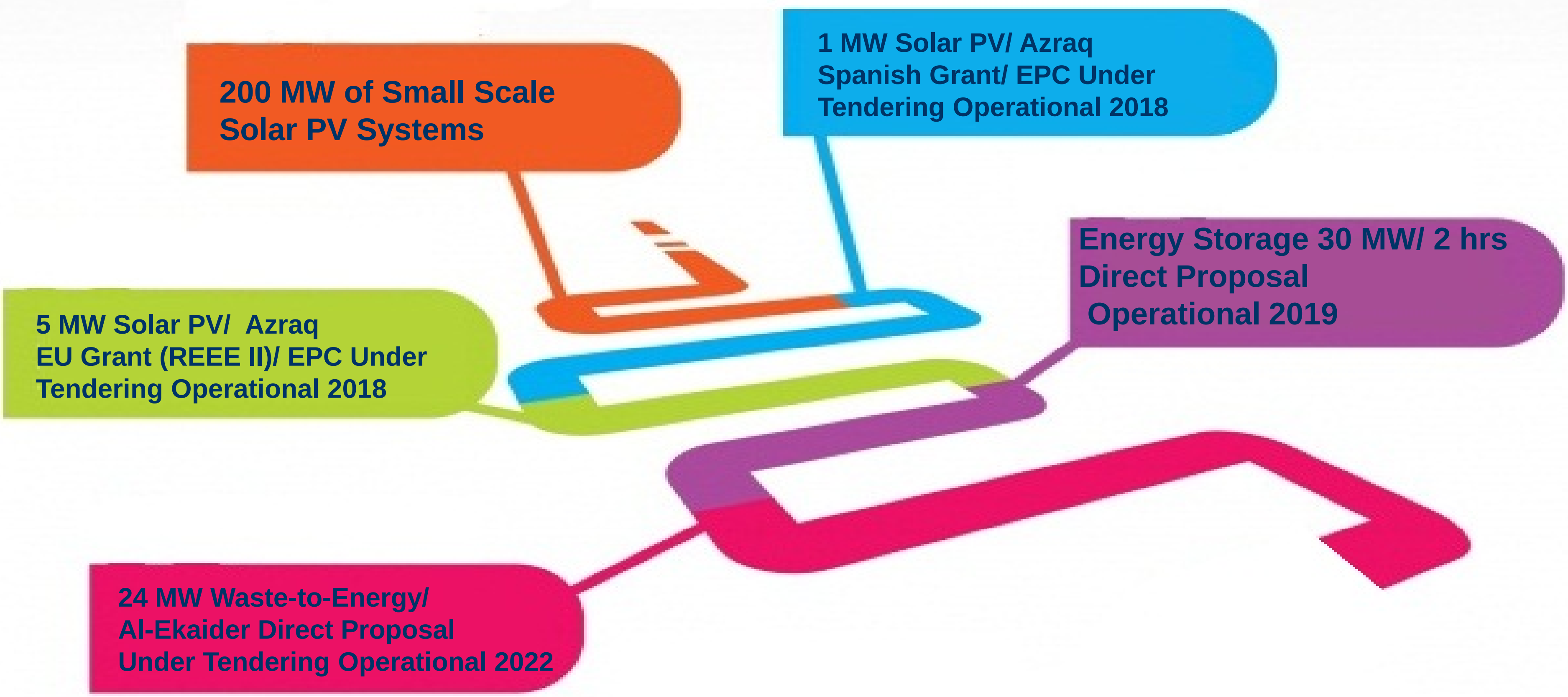
Energy Strategy Main Goals

- Diversifying the energy resources
- Increasing the share of local resources in the energy mix
- Reducing the dependency on imported oil
- Enhancing environmental protection

This will be achieved through

- Expanding the development of renewable energy projects
- Maximizing the utilization of domestic resources
- Generating electricity from oil shale & nuclear energy
- Promoting energy efficiency and awareness

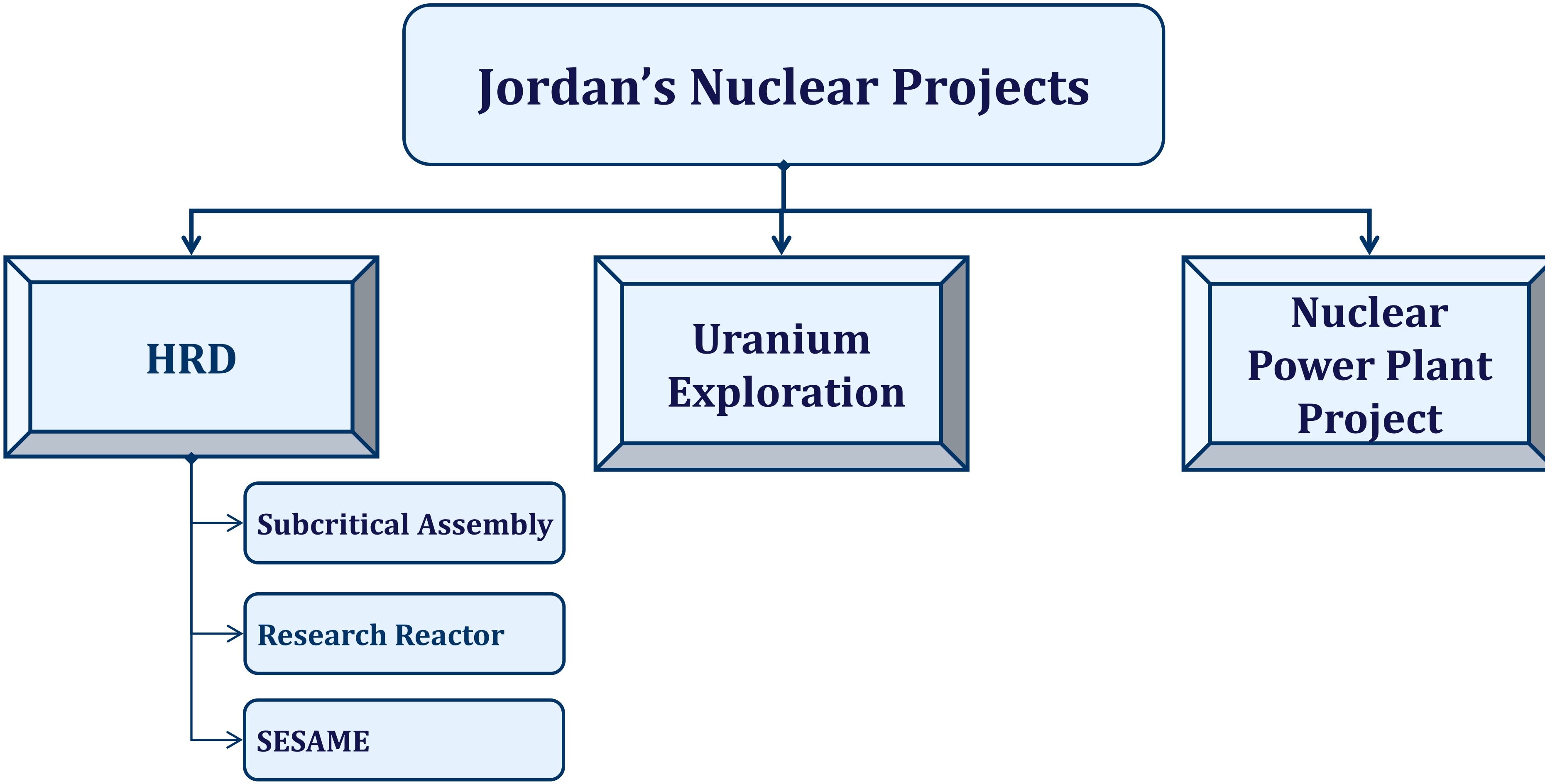
Renewable Energy Projects in the Pipeline (1)



Renewable Energy Projects in the Pipeline (2)

Example of Projects: Arabia One (Ennera) at Ma’an

JAEC’s Current Activities



Jordan Research & Training Reactor

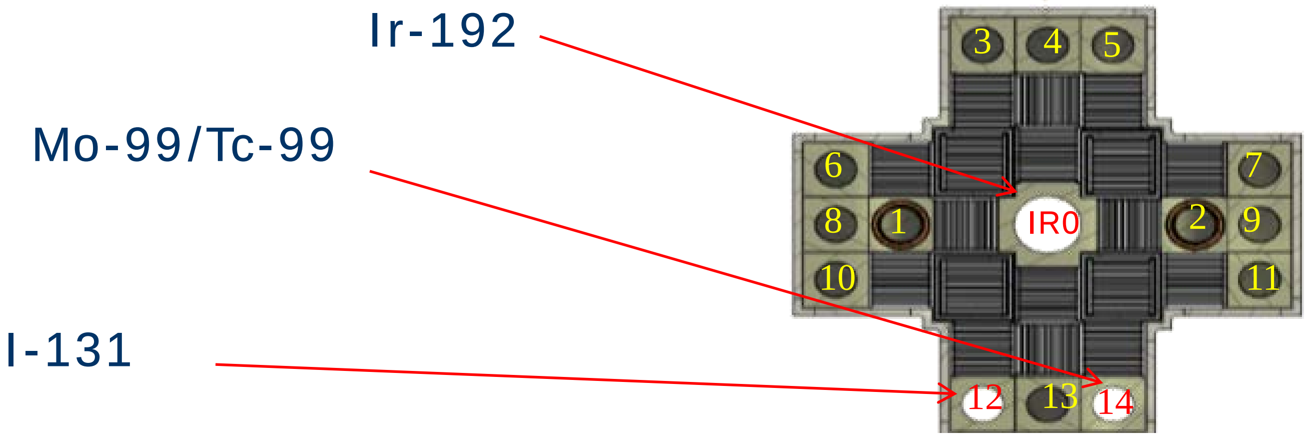
Reactor Type	Open Pool
Thermal Power	5 MW (upgradable to 10 MW)
Max. ϕ_{th} ($n/cm^2 \cdot s$)	1.5×10^{14} in the core (central trap) 0.4×10^{14} in the reflector region
Fuel Type & Material	Plate type; 19.75% enriched, U_3Si_2 in Al matrix
Fuel Loading	18 fuel assemblies, 7.0 kg of U^{235} (*equilibrium cycle*)
Coolant/Moderator **Cooling Method**	H_2O Downward, forced convection flow
Reflector	Be + D_2O
Utilization	**A Multipurpose Facility** Neutron Beam Applications (radiography, scattering, research etc.) - Neutron Irradiation Services (RI Production, NAA, NTD, etc.) - Training, Research & Education - Radioactive Waste Treatment

JRTR Utilization

Existing Capabilities of the JRTR

Radioisotopes Production

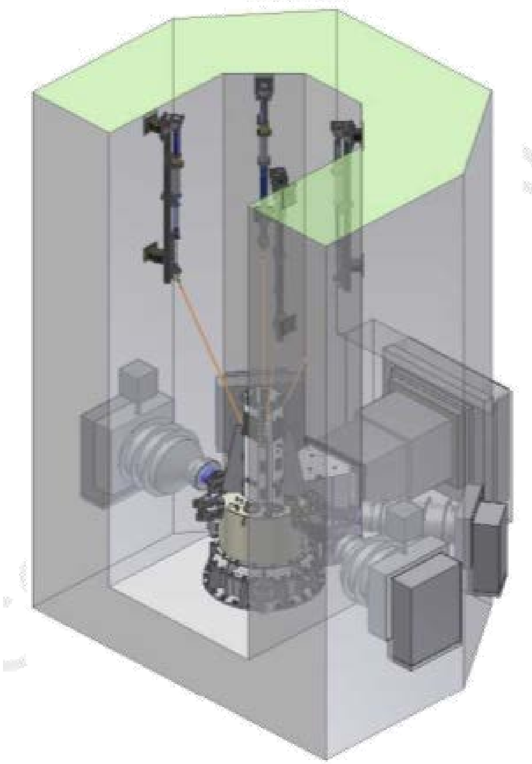
^{192}Ir: 48,000 Ci/year
^{131}I: 960 Ci/year
^{99}Mo/^{99m}Tc: 240 Ci/year

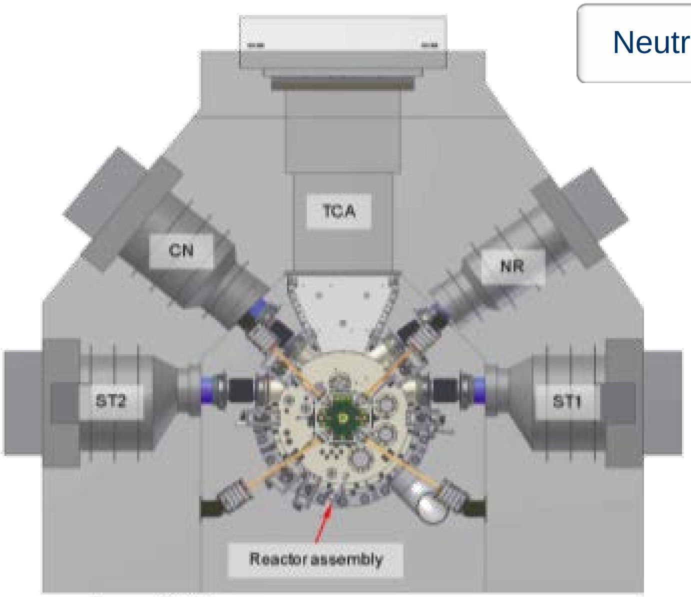


JRTR Utilization

Potential Capabilities of JRTR

- Cold Neutron
- Neutron Scattering
- Neutron Radiography
- Neutron Transmutation Doping



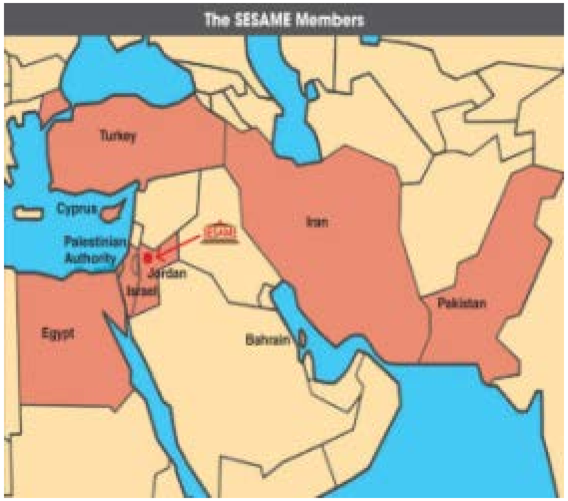


Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME)

SESAME

A 2.5 GeV light source facility, under construction near Amman, Jordan

Modelled on CERN.

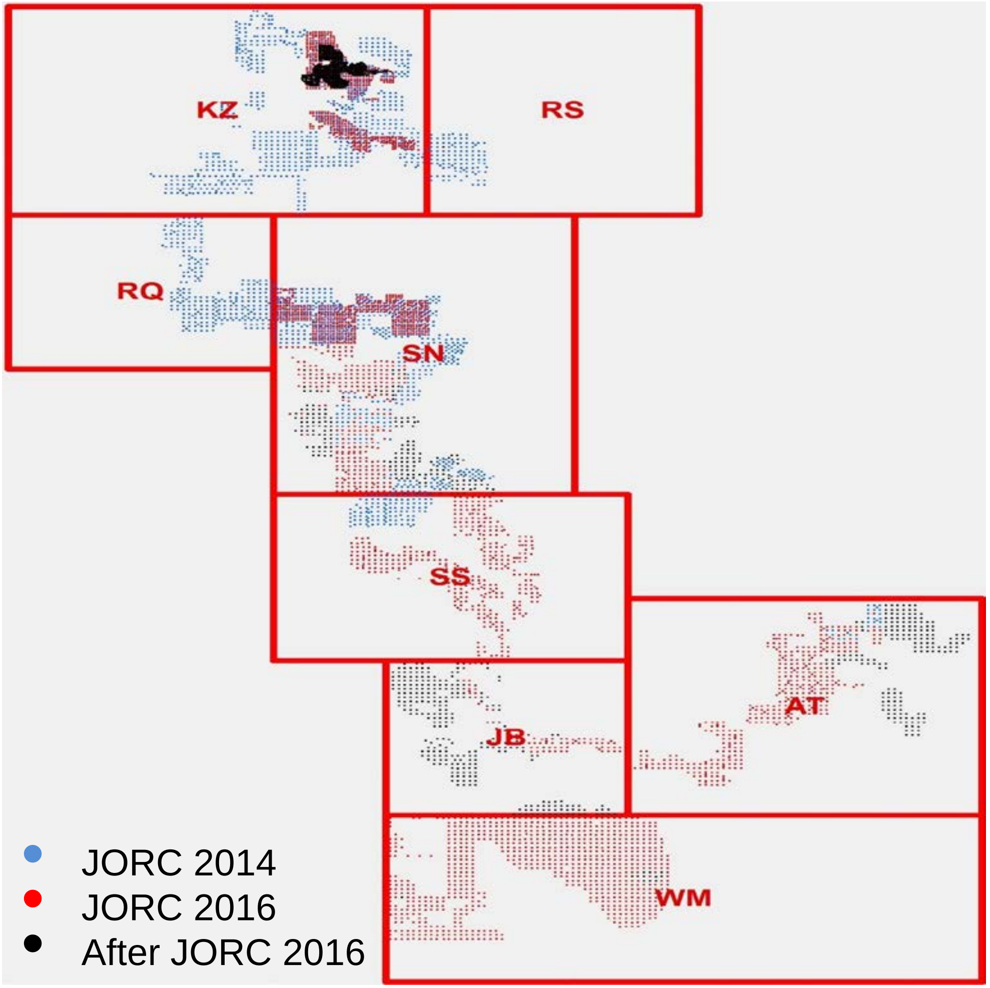


Members: Bahrain, Cyprus, Egypt, Israel, Iran, Jordan, Pakistan, Palestine, Turkey.

Observers: China, Brazil, EU, France, Germany, Greece, Italy, Japan, Kuwait, Portugal, Russia, Spain, Sweden, Switzerland, UK and USA.

Purpose: Foster excellent science and technology in the Middle East (and prevent or reverse the brain drain) + Build bridges between diverse societies.

JUMCO Exploration Phases



JORC 2014

- 200 x 200 m Exploration Grid
- 1963 Trenches included in report
- Exploration carried out in 5 areas (KZ,RS,RQ,SN,SS)

JORC 2016

- 3055 Trenches included (not included in JORC 2014)
- 200X200 m Grid in new areas
- 100X100 m in selected areas (IMA)

After JORC 2016 (current activity)

- Infill Grid 50X50 m in selected areas
- Explore new areas 200x200 m Grid
- JORC 2018 expected in June

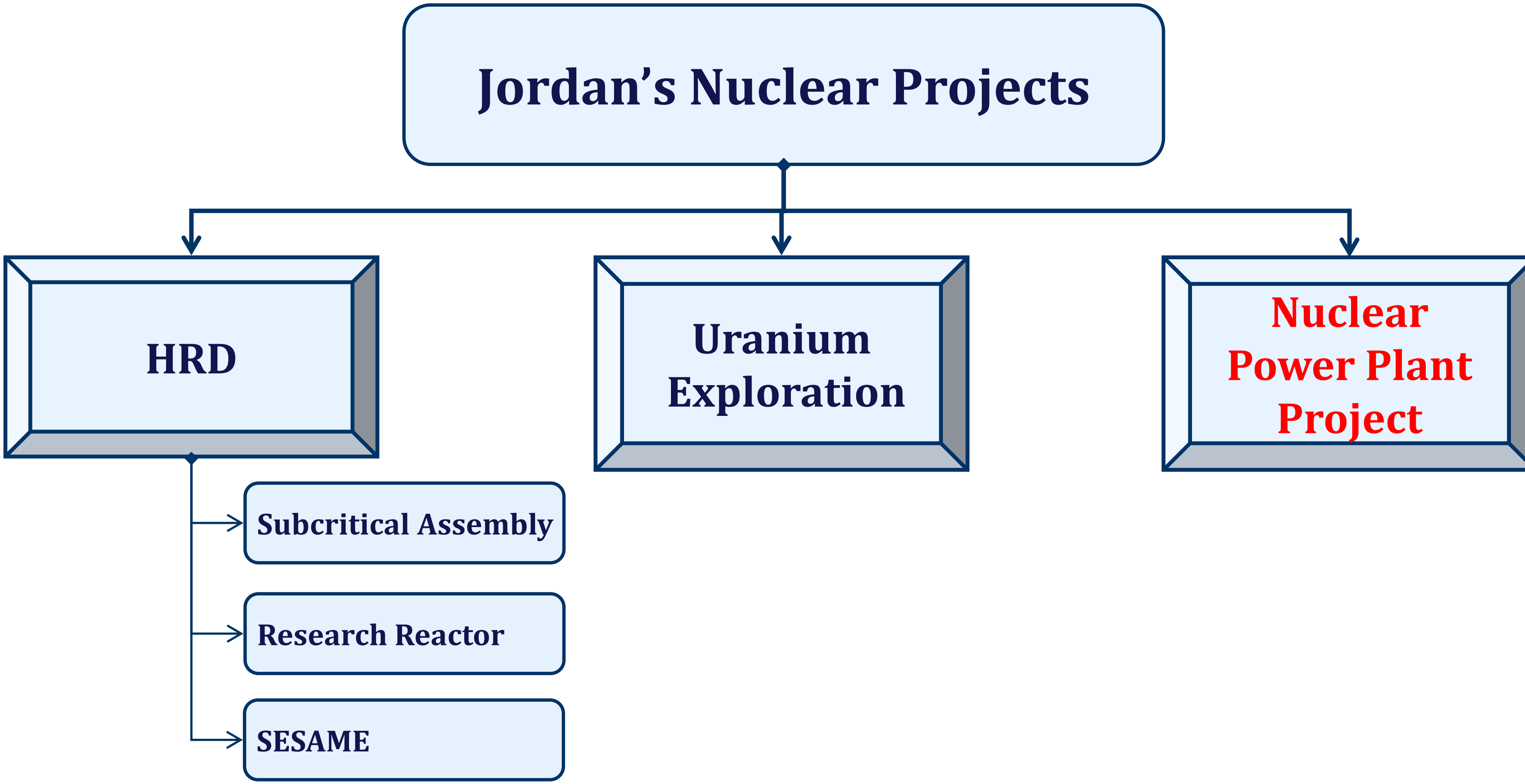
Resources of CJUP Reported at 94ppm U3O8 Cut-off *(Source: CJUP Mineral Resource Report April 2016)*

Category	'Surficial' Mineralisation			'Deep' Mineralisation			Both Mineralisation sub-types		
	Tonnage (Mt)	Grade (U_3O_8 ppm)	Metal (U_3O_8) Kt	Tonnage (Mt)	Grade (U_3O_8 ppm)	Metal (U_3O_8) Kt	Tonnage (Mt)	Grade (U_3O_8 ppm)	Metal (U_3O_8) Kt
Indicated	20.5	175	3.6	34.0	133	4.5	54.5	149	8.1
Inferred	67.2	150	10.1	167.7	126	21.2	235.0	133	31.2
Total	87.8	156	13.7	201.7	127	25.7	289.5	136	39.3

Project Milestones

- Exploration and resource estimation will continue to enhance confidence and upgrade classification (Inferred →Indicated & Indicated → Measured).
- Construction of pilot plant is expected to be concluded and commissioned in 2018.
- Project pertinent parallel and supporting studies i.e., Mining Plan, Water, EIA,... will continue/start in 2018.
- Bankable Feasibility Study is expected to be concluded in 24 months.

JAEC's Current Activities



Rationale of the Project:
Benefits from nuclear power development

Public Income

- Taxes from local suppliers and electricity sales
- Increase of region investment attractiveness
- Higher domestic value creation than for imported fossil fuels

Energy Sector

- Growing electricity demand coverage
- Stable base-load power supply

Employment

- *Up to 10,000 employees hired for NPP construction*
- *Up to 2,500 new jobs created for NPP operation*

National Development

- *Local higher education system and workforce skills development*
- *National industry development*

Jordan's Nuclear Strategy

Pursue two parallel tracks:

A. Small Modular Reactors (SMRs)

B. Large Nuclear Reactor

Why SMRs?
Technical

- Because of their small size and modularity, SMRs could almost be completely built in a controlled factory setting and installed module by module. This improves the level of construction quality and efficiency, thus mitigating some of the construction risks typically associated with large reactors.

- Their small size and passive safety features lend them to countries with smaller electricity grids and less experience with nuclear power.

- Potential for sub-grade (underground) location of the reactor unit providing more protection from natural (e.g. seismic earthquakes or tsunami according to the location) or man-made (e.g. aircraft impact) hazards.
- The compact architecture enables modularity of fabrication (in-factory), which facilitates implementation of higher quality standards.

- The modular design and small size support having multiple units on the same site.

- Ability to remove reactor module or in-situ decommissioning at the end of the lifetime.

- Lower requirement for access to cooling water – therefore suitable for remote regions and for specific applications such as mining or desalination.

Why SMRs?
Economics

- Achieving ‘economies of scale’ for a specific SMR design will reduce costs further. Most SMRs are designed with series production in mind.

- Size, construction time, and efficiency along with passive safety systems (requiring less redundancy) lead to smaller investment requirement for SMRs compared to that of large nuclear. In turn, procuring the funding and financing for these projects should in turn be easier or a less complex process.

- From commitment of Equity to Commissioning, SMRs require a shorter time to construct. This is a more attractive proposal for investors.

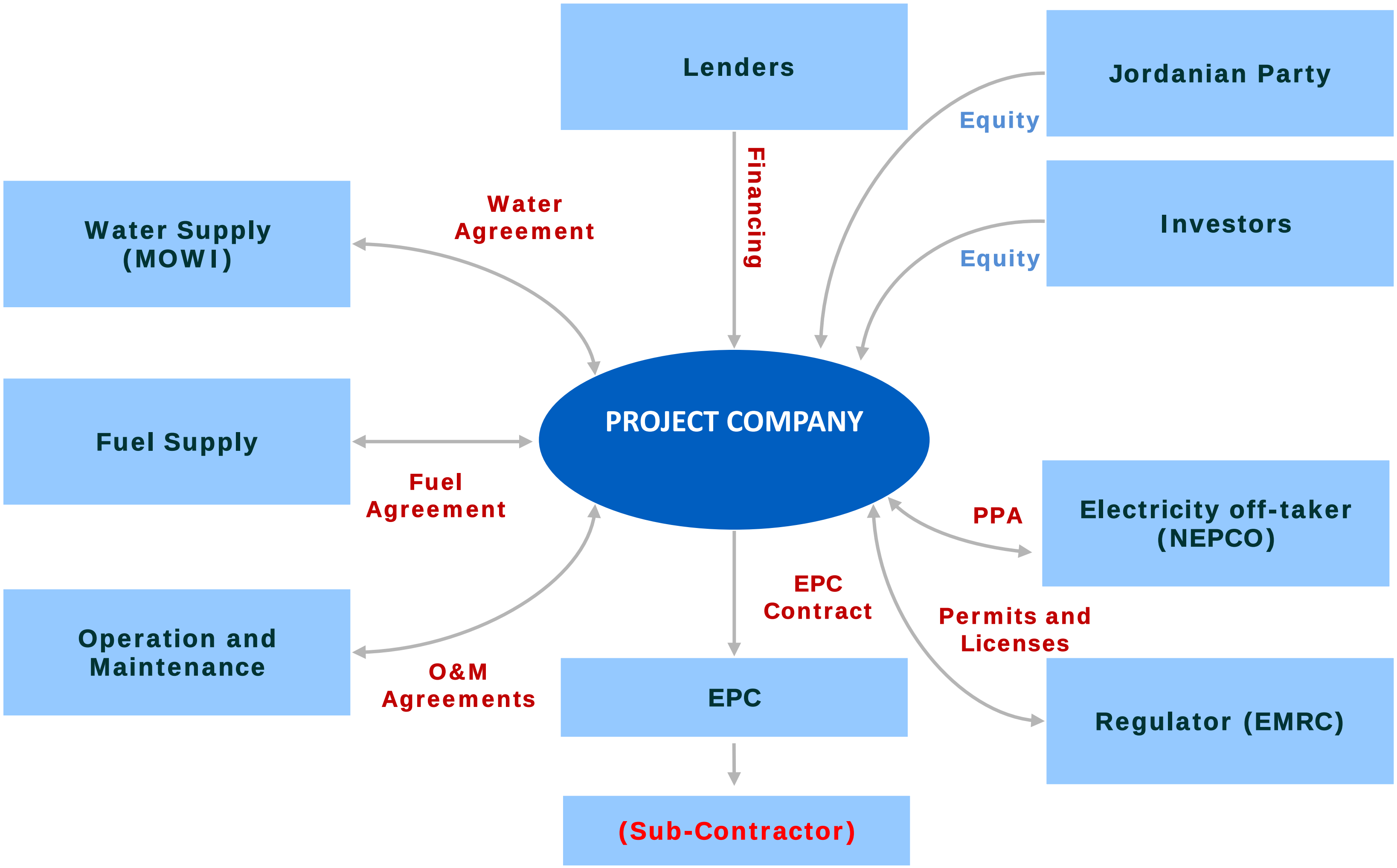
SMRs for Near Term Consideration

Name	Capacity	Type	Developer
ACP100	100 MWe	integral PWR	CNNC, China
HTR-PM	110 MWe	HTR	CNEC, China
SMART	100 MWe	integral PWR	KAERI, South Korea
RITM-200	50 MWe	PWR	OKBM, Russia

Large Nuclear Reactor

- Focused on GIII+ 1000 MWe
- Studies underway:
  - Siting Characterization
  - Grid Stability
  - Water Supply
  - Offsite Infrastructure

Generic Project Structure



Thank You