Human Resources Capacity-Building for the Jordanian Nuclear Programme

Presentation to the Conference:

Sharing Knowledge Across the Mediterranean

Kamal J. Araj

Jordan Atomic Energy Commission

Jordan's Nuclear Strategy

- Ensuring security of supply including fuel
- Leveraging of national Uranium assets
- Promoting public/private partnerships
- Ensuring effective technology transfer and national participation in all phases
- Providing for water desalination and eventually hydrogen production
- Development of spin-off industries
- Enhancing electricity export
- Enabling competitive energy-intensive industries

Challenges

Several challenges need to be addressed in order to develop Jordan's nuclear energy programme:

1. Siting, technology choice, and grid limitation
2. Exploitation of Uranium
3. Fuel cycle and waste management
4. **Human Resources Development**
5. Funding
6. Political environment

HR is the Greatest Challenge

- A large number of countries expressing their interest or declaring their intention to peruse a nuclear power program for the first time.
- The greatest challenge that most developing countries will face in their effort to introduce nuclear power will be having enough qualified nuclear engineers and experts.
- Must recognize the vital importance of nuclear knowledge, and that human capacity building is the first step in the effective planning and implementation of a successful nuclear power program.

Human Resource Development Approach

The HRD will be carried out:

1. Academic Education
2. Professional Training

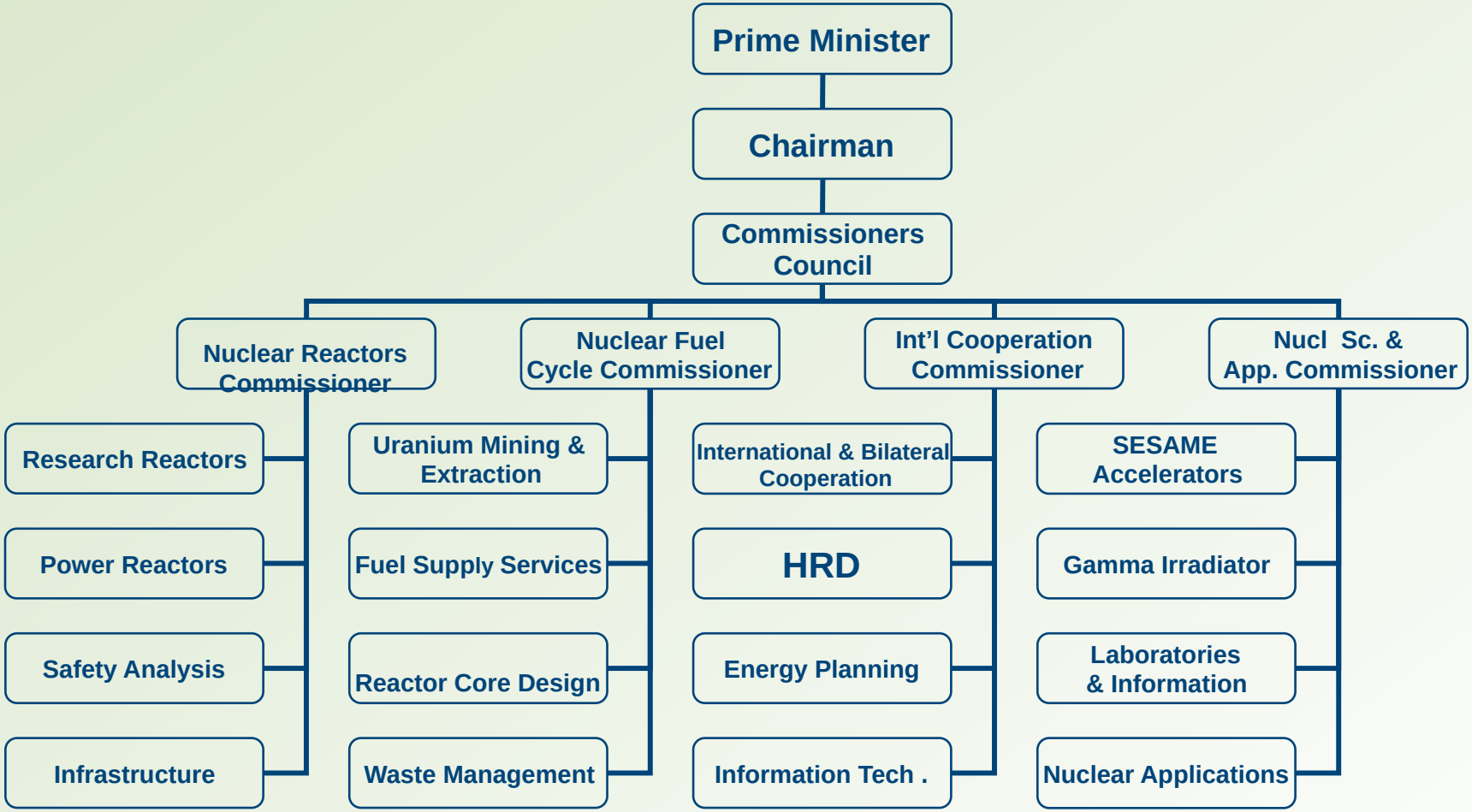
Both in-country and abroad opportunities will be explored

JAEC Role in HRD

JAEC will lead the national HRD for NPP

- Effective workforce planning, including anticipating needs for new employees, succession planning.
- Developing and maintaining relationship with educational and professional organizations.
- Monitoring situations external to the organization for conditions that may have impact on its HR.

Organizational Chart of JAEC



Supporting Facilities

- A subcritical assembly is under procurement from China for JUST
- Research Reactor (RR) procurement will benefit training of nuclear engineers & operators and other technicians

Nuclear Research Reactor

- The research and test 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

Nuclear Research Reactor (2)

- Four technical and financial proposals were submitted on April 15th ,2009:
  - Korea (KAERI)
  - China (CNNC-China Zhongyuan Engineering Corp.)
  - Russia (JSC Atomstroyexport)
  - Argentina (INVAP)

- All four companies sent technical teams to clarify their financial and technical proposals with RR Technical Committee during July 2009.

- All four bidders were given another chance to submit their revised final technical and financial offers by end of Oct. 2009

- The technical and financial evaluation of proposals was completed and a preferred bidder selected: Consortium led by KAERI/DAEWOO

International& Bilateral Cooperation

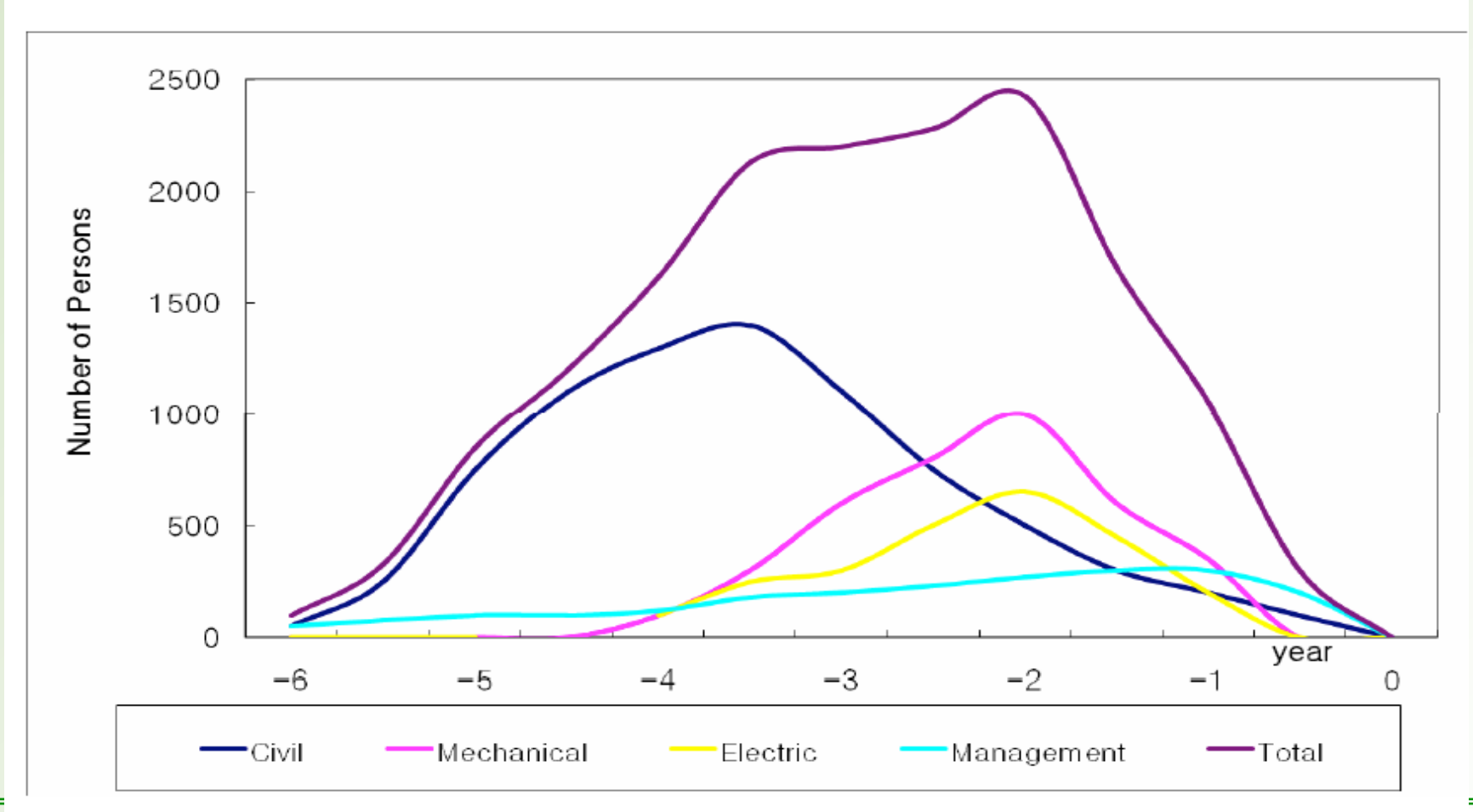
- **International (IAEA, GNEP)**
- **Bilateral**
  - Signed NCAs: France, China, South Korea, Canada, Russia, UK, Argentine, and Spain
  - Will sign within two months with Romania
  - Ongoing negotiations with USA and Japan

Manpower Requirements at the Peak during Implementation of a NPP Project

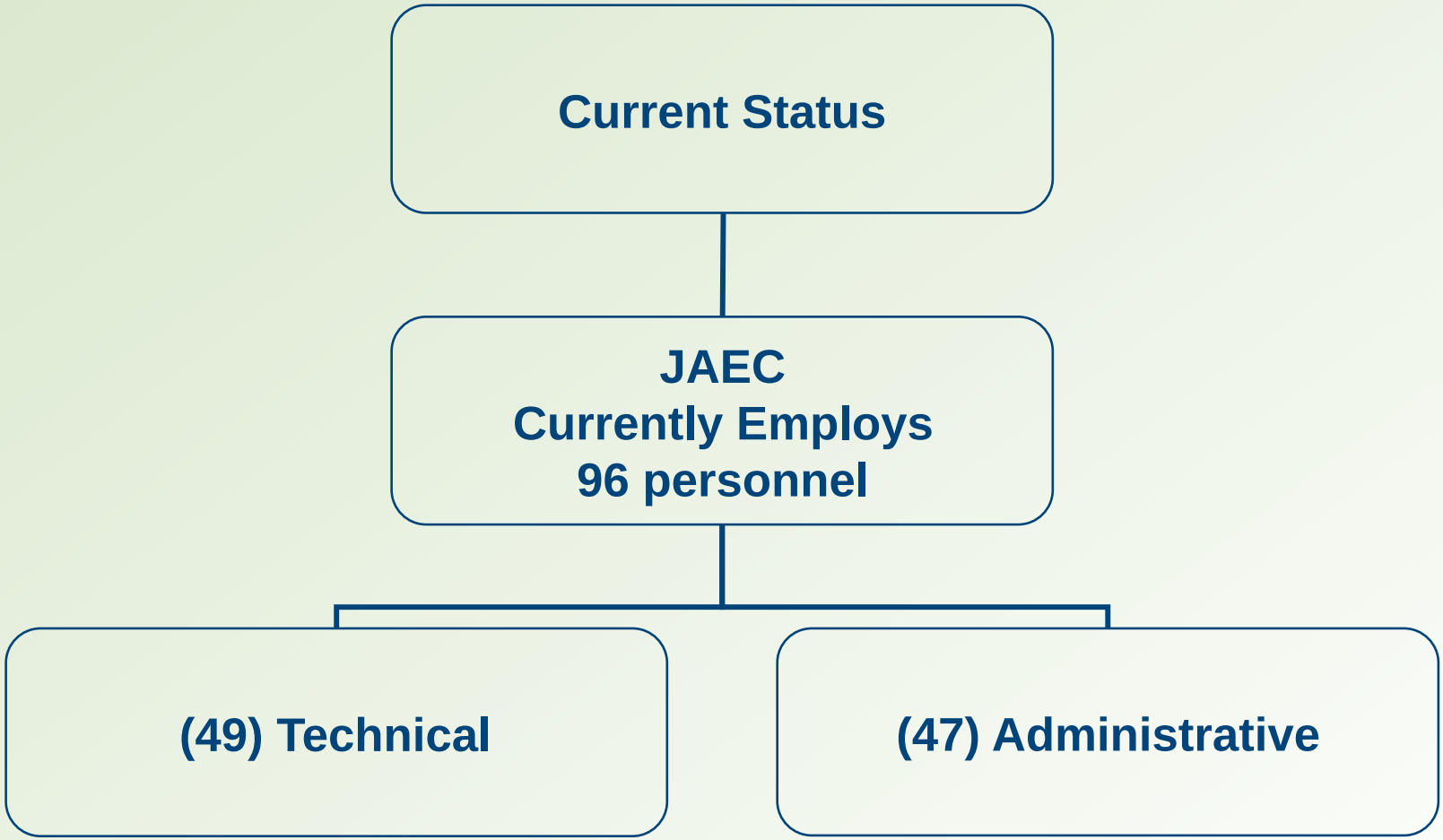
IAEA

Activity \ Manpower classification		High-grade Professionals	Professionals	Technicians	Craftsmen	Total
1. Pre-Project activities		1	27	2		30
2. Project Management	Utility	8	47	10		65
	Main-contractor	8	22	5		35
3. Project engineering		25	185	160		370
4. Procurement		8	12	10		30
5. Quality assurance / Quality control		8	32	60		100
6. Manufacturing of equipment & components		90	210	600	2100	3000
7. Plant construction		10	80	340	2270	2700
8. Plant commissioning		10	40	50	100	200
9. Operation & maintenance		25	25	140	30	220
10. Nuclear fuel cycle (fuel fabrication)		5	35	70	30	140
11. Nuclear Licensing & Regulation		45	5			50
Total		243	720	1447	4530	6940

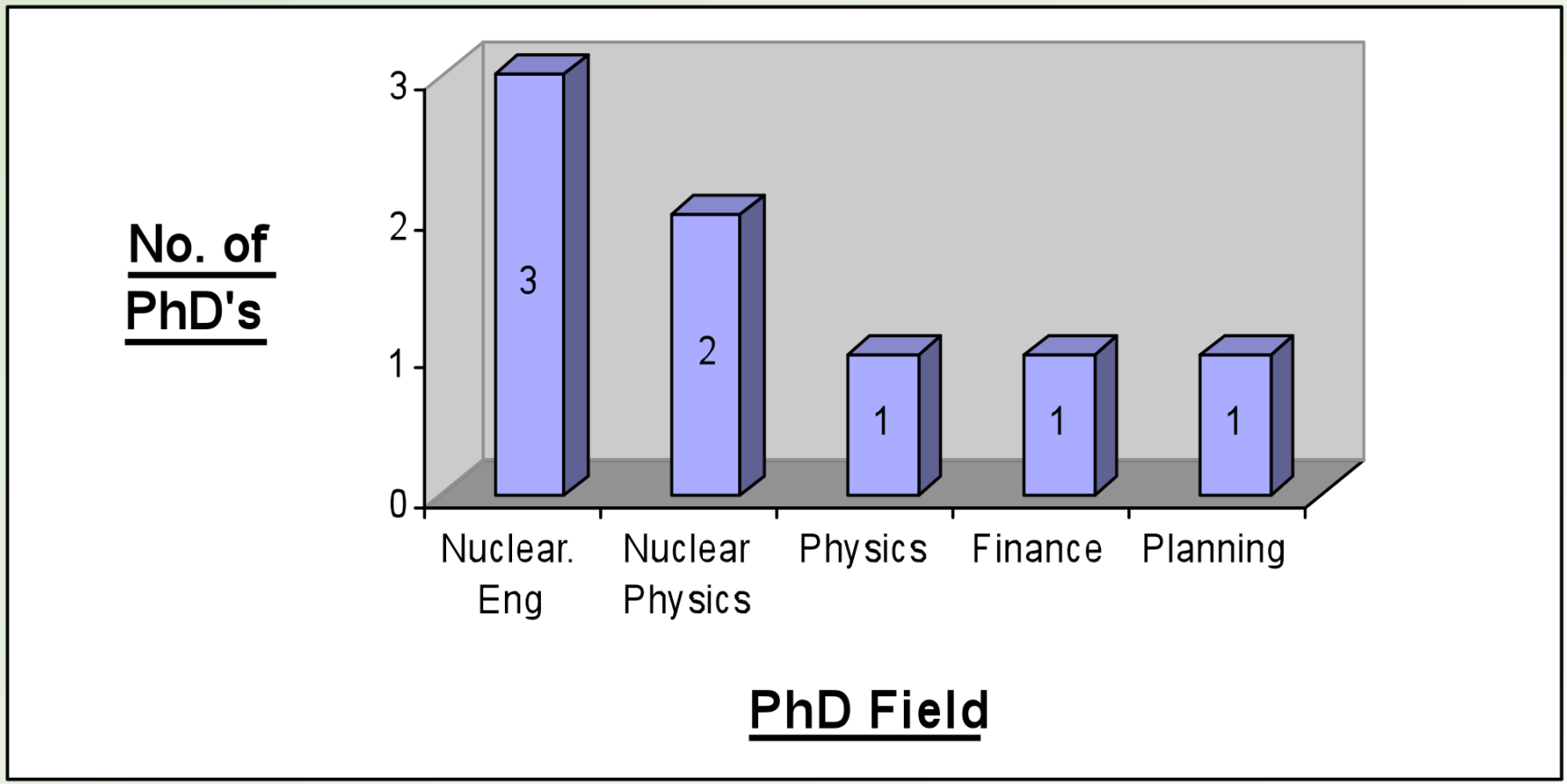
Manpower Loading during Implementation of a NPP Project



Status of Employment in JAEC

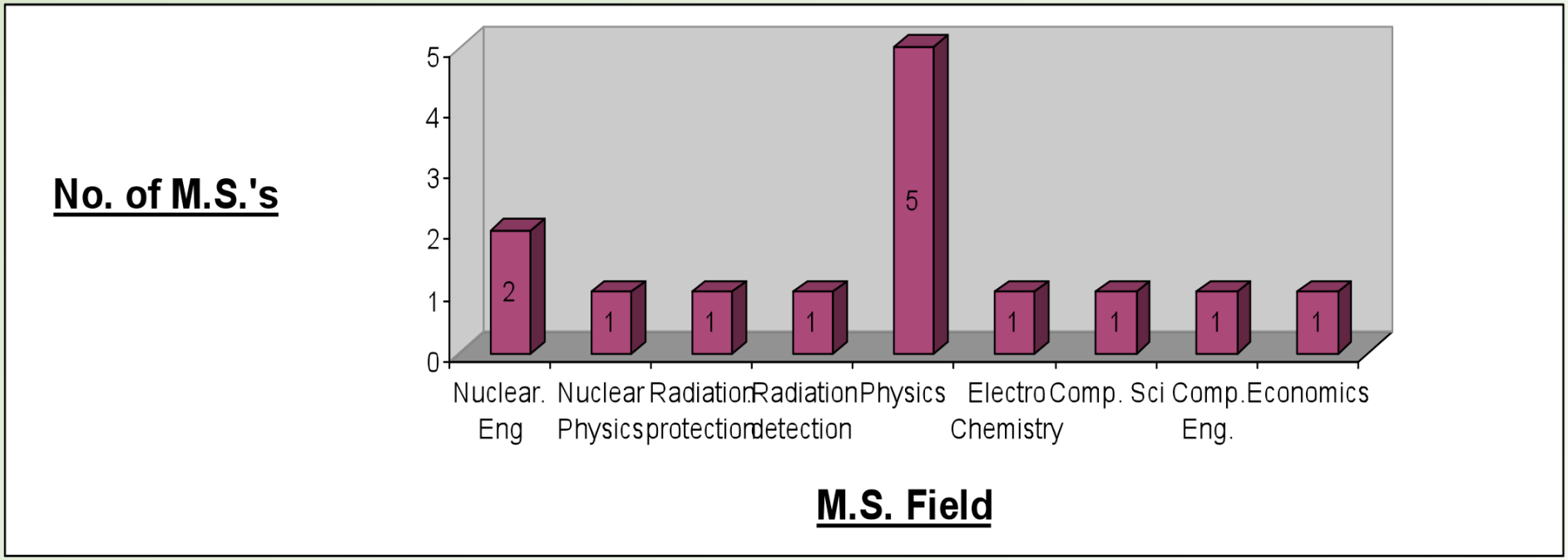


PhD Staff at JAEC



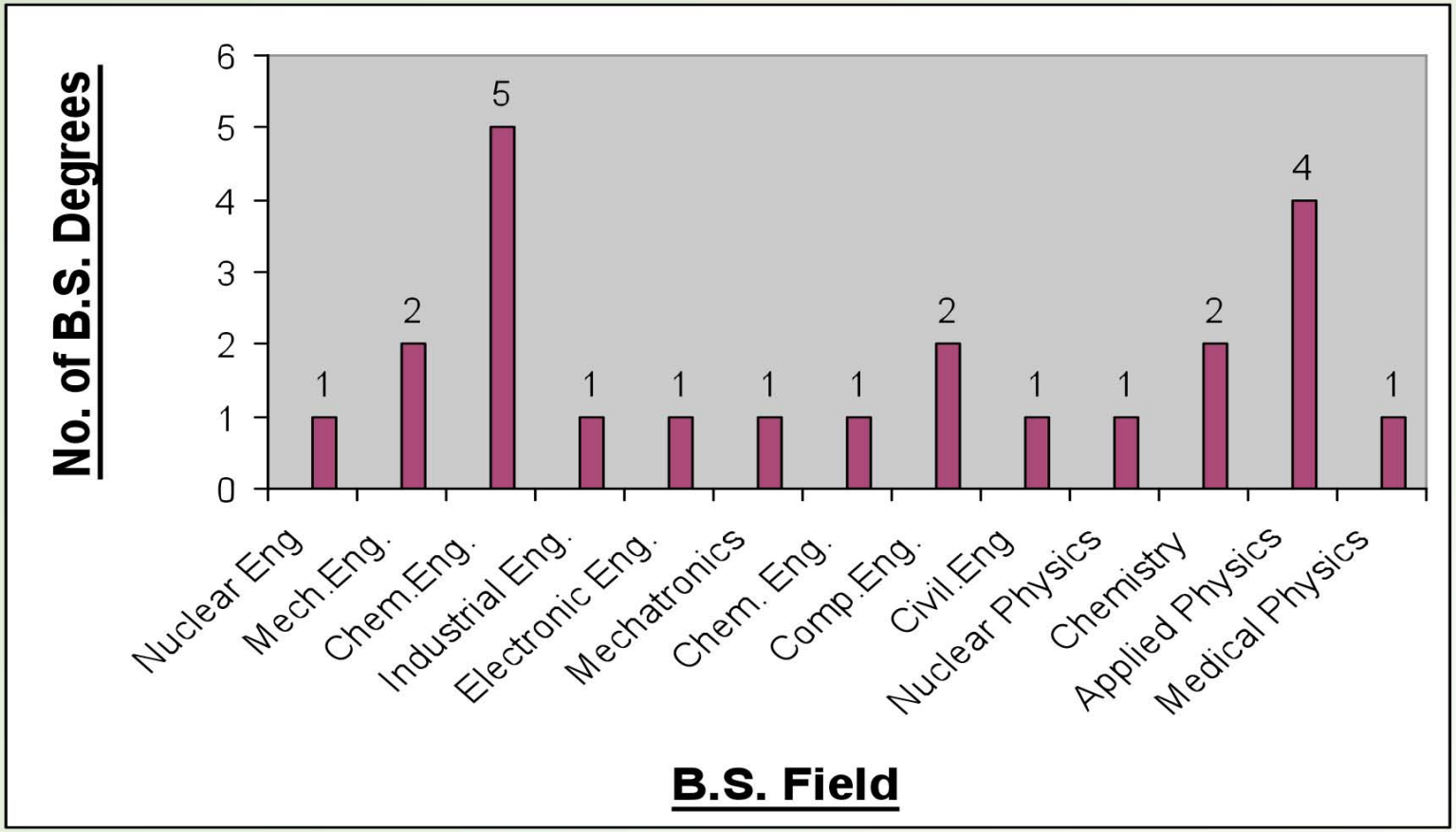
* Total (2009): 8

M.S. Staff at JAEC



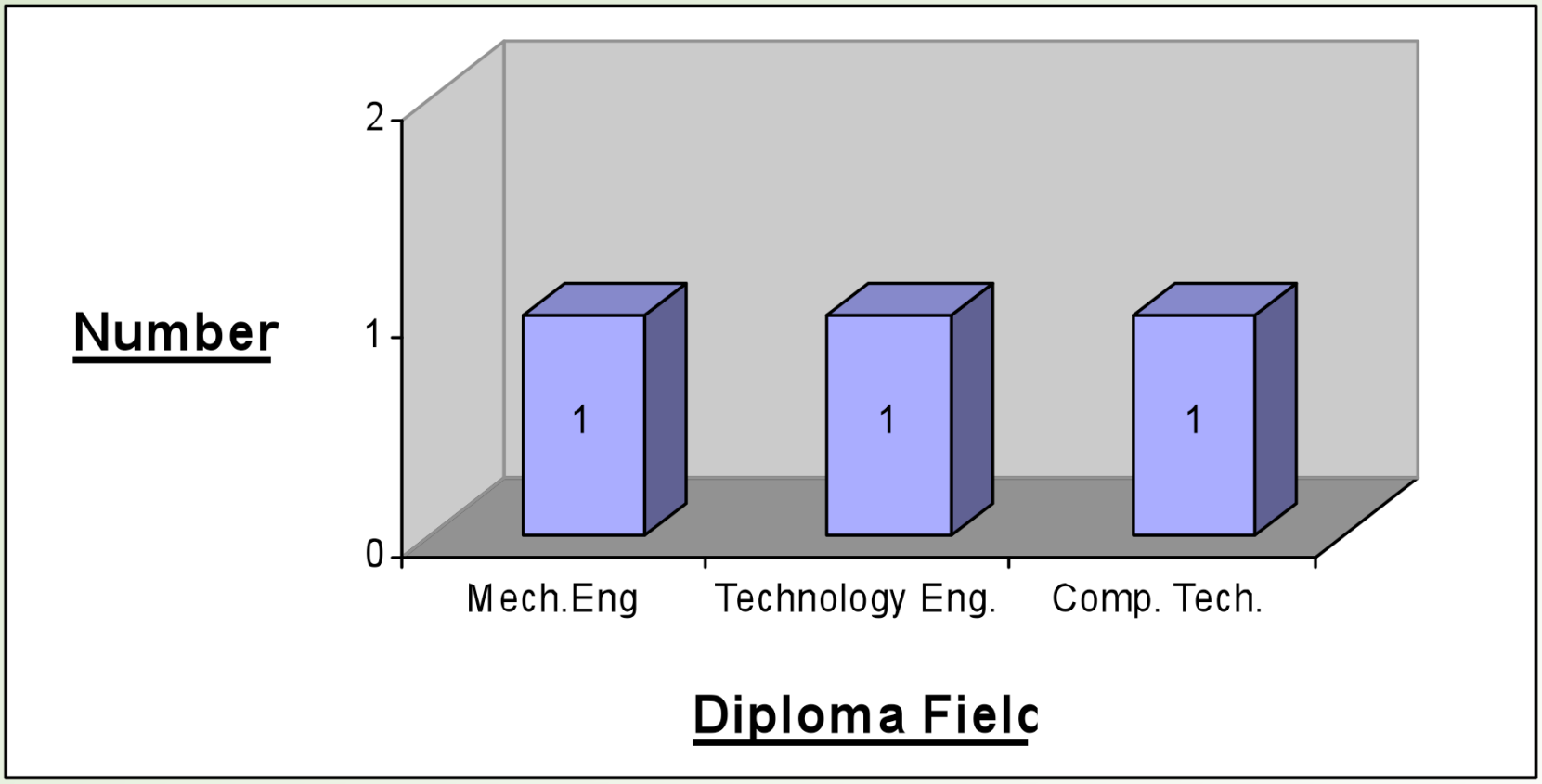
*** Total (2009) : 15**

B.S. Staff at JAEC



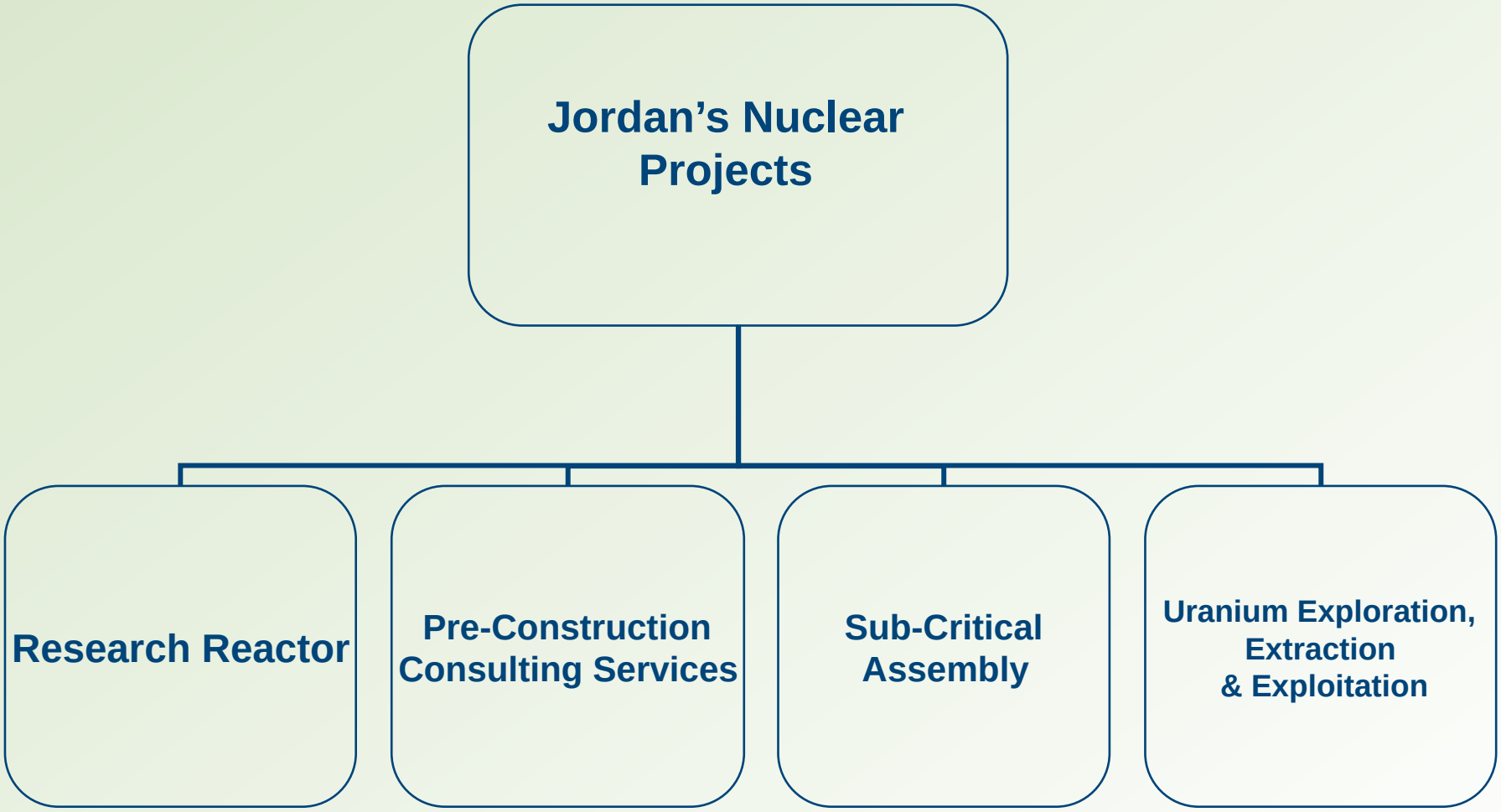
*** Total (2009) : 23**

Community College Staff

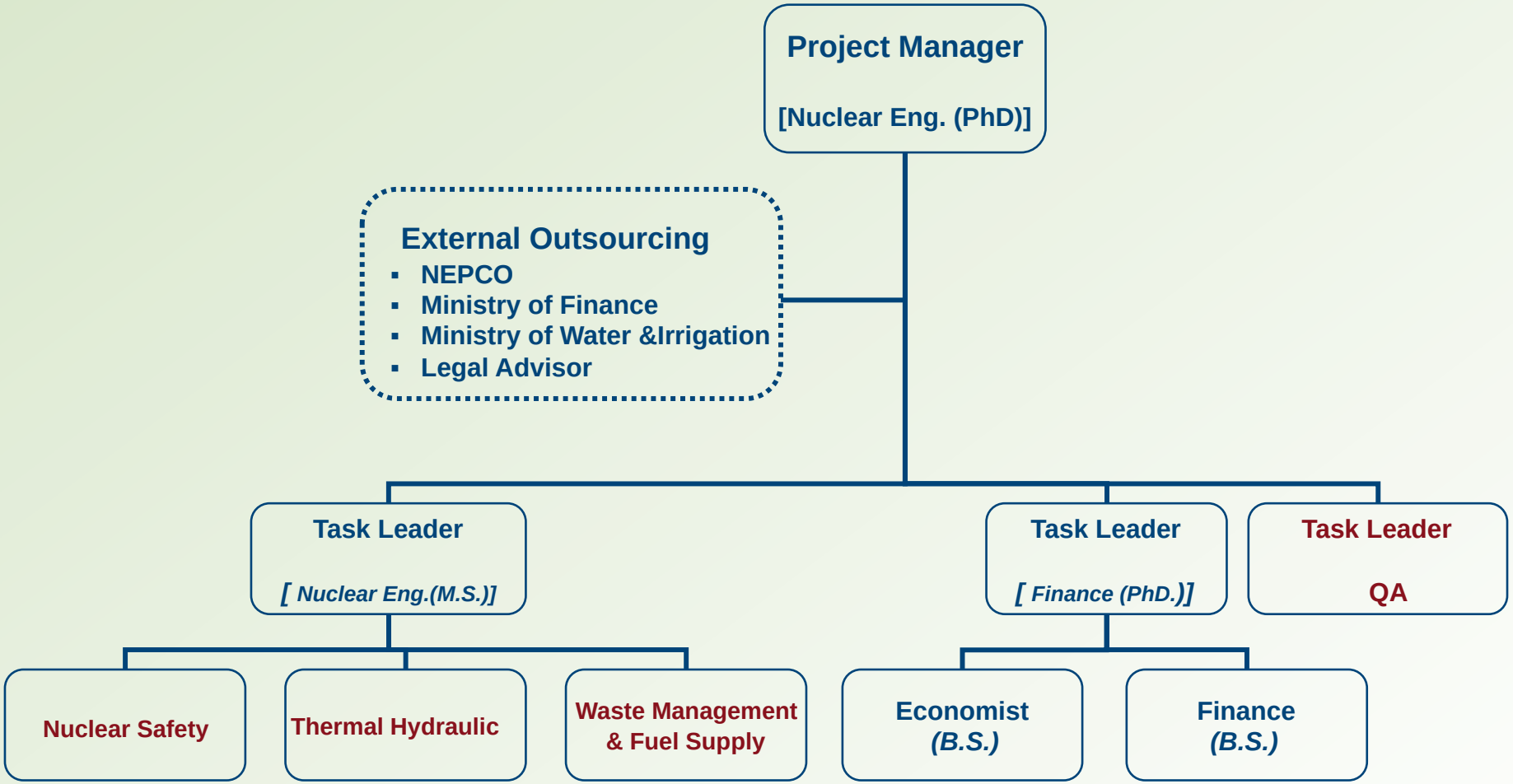


*** Total (2009) : 3**

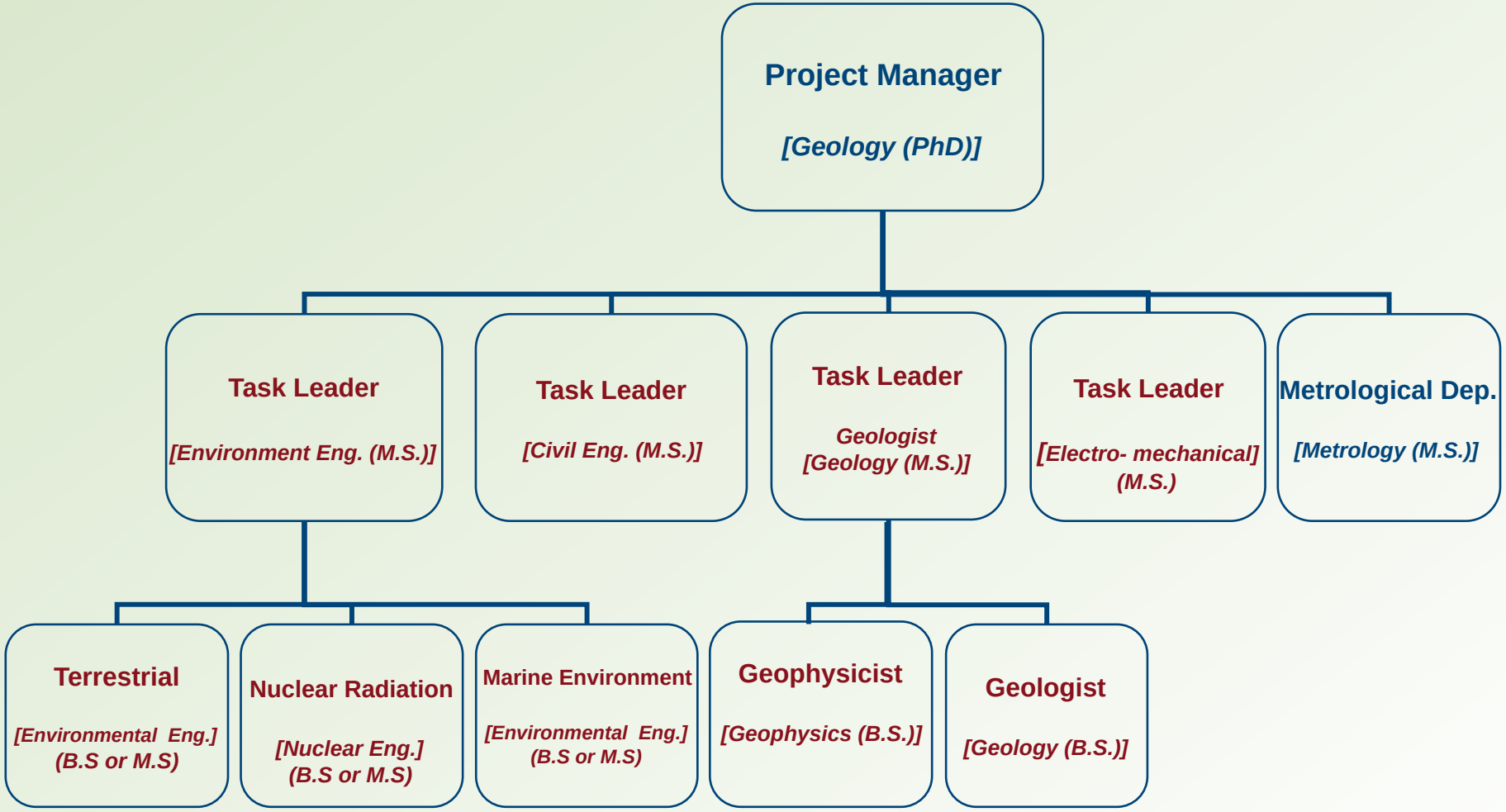
Current Activities



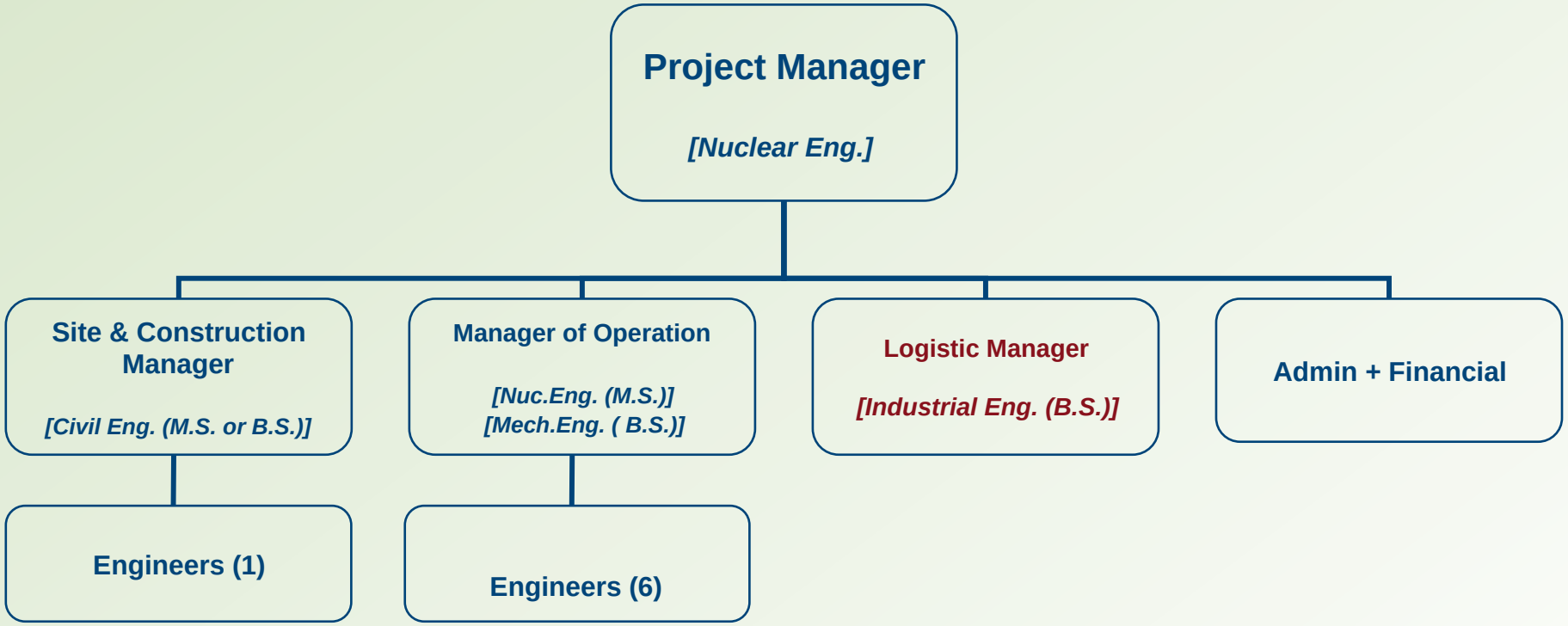
Pre-Construction Consulting Services



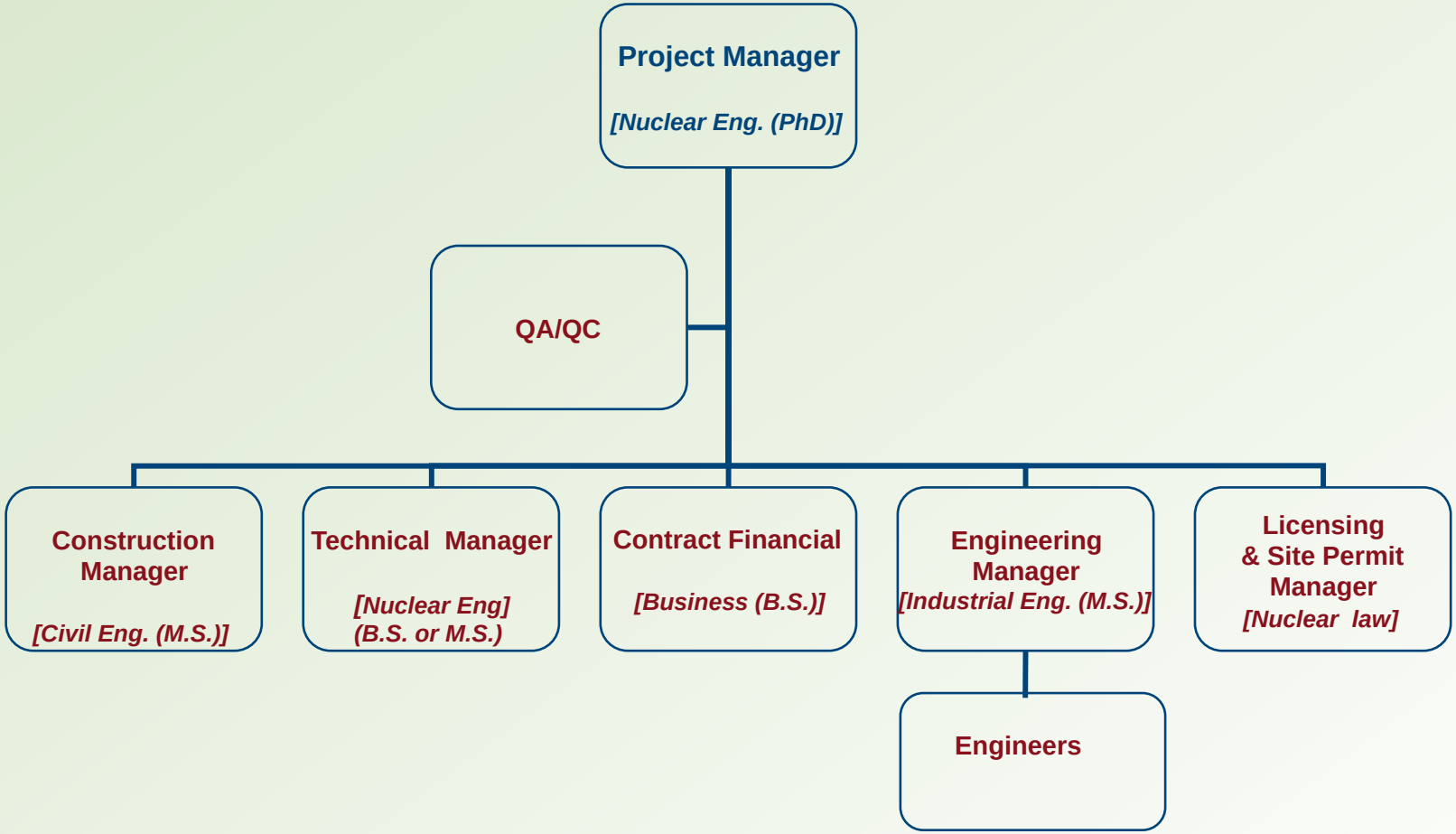
Site Characterization Project



Sub-critical Assembly



Research Reactor



Training

Training Programme

- *Fundamental* : Provide new staff with basic knowledge of NPP (Nuclear Theory, General Plant System, etc.)
- *Practical:* Provide essential and practical knowledge to improve existing and new staff's expertise (Operation, Mechanical, Electrical, I&C, Core & Fuel, Safety, etc.)
- *Advanced:* Provide advanced specialized training
- *Project Management*
- *Regulatory*

Planned Training Programmes

- Every contract that JAEC negotiates includes training component
- Local involvement and technology transfer from design to operation & maintenance
- Close cooperation for training and expert visits with international Laboratories.
- IAEA projects
- Arab Atomic Energy Commission (AAEC) projects
- OJT training by international experts

IAEA Technical Cooperation

- Specialized training courses & workshops
- Fellowships programmes and OJT
- Scientific Visits
- National Consultants
- Expert sevices

Education

Status of Universities and Community Colleges in Jordan

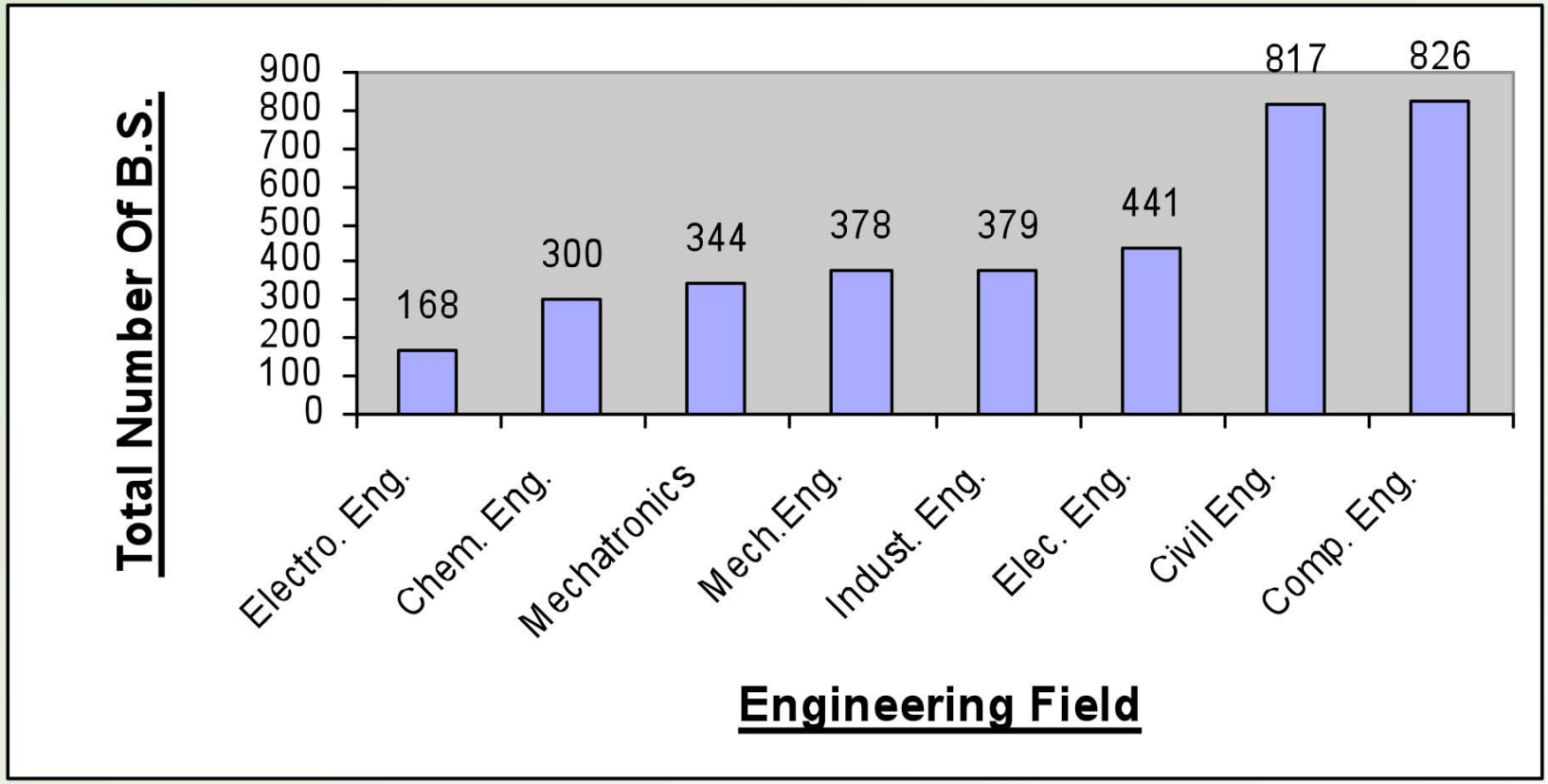
- **Number of Universities in Jordan: (25)**
  (10 public ,15 private).
  8097 graduates in scientific fields.
  398 Postgraduates.

- **Number of Community Colleges: (35)**
  (15 Public and 20 private).
  439 graduates in scientific fields.

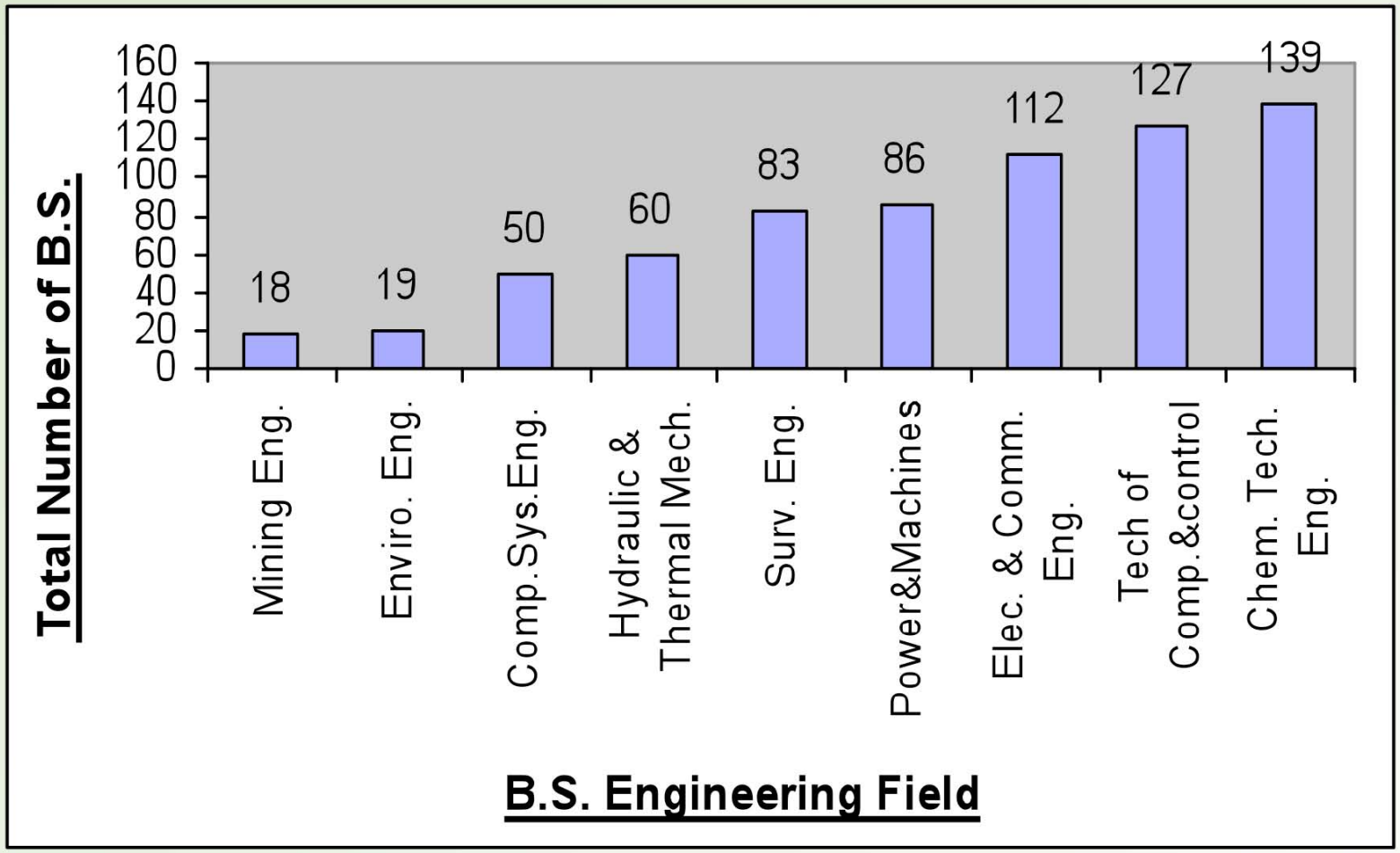
Total Number of Undergraduate & Graduate Students from Public Universities in Jordan for the Year (2008/2009)

Degree	Specialization	
	Engineering	Natural Sciences
B.S.	4347	3750
M.S.	174	201
PhD	6	17

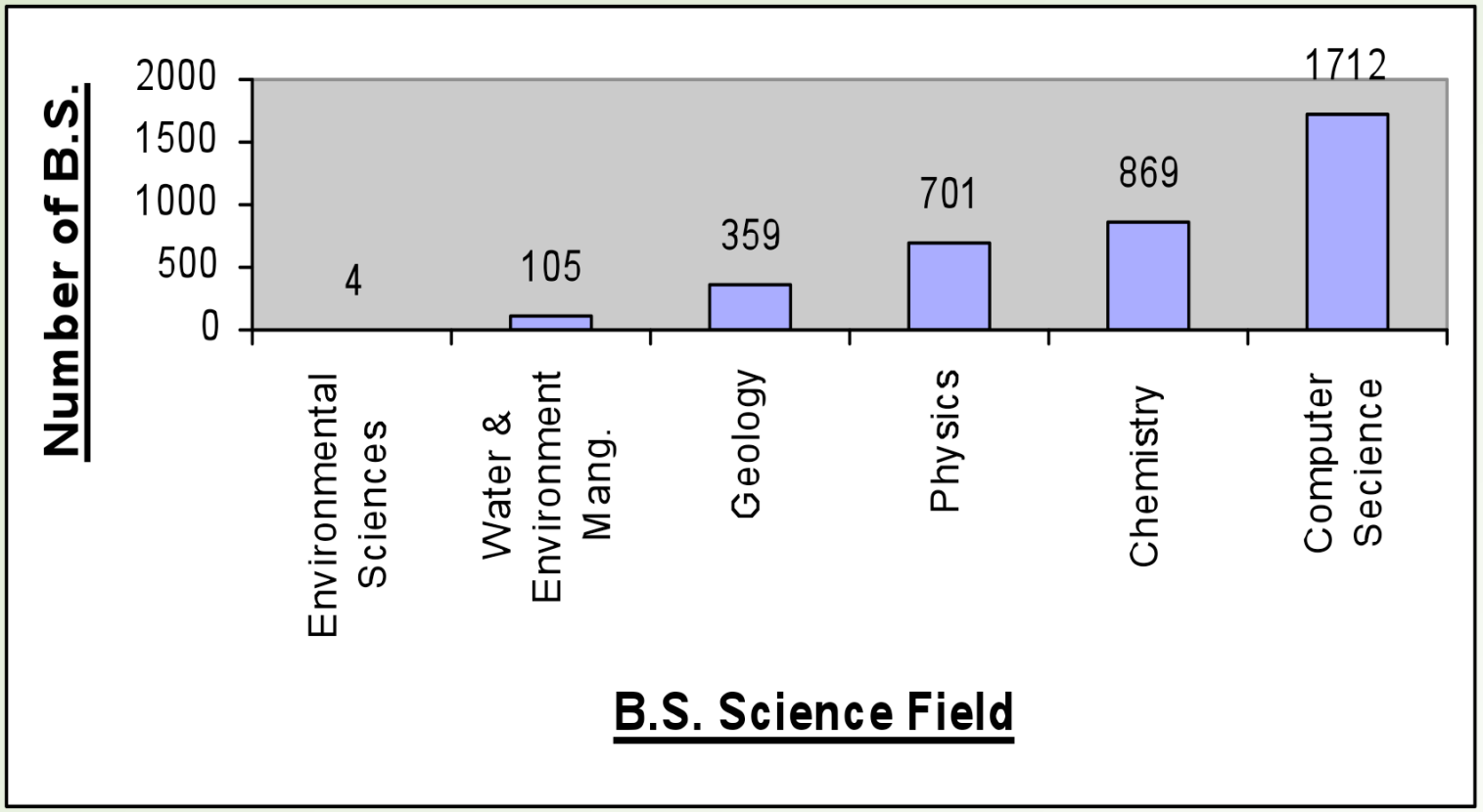
Distribution of B.S. Graduate Students in Engineering from Jordanian Universities by Field for the Year (2008 / 2009)



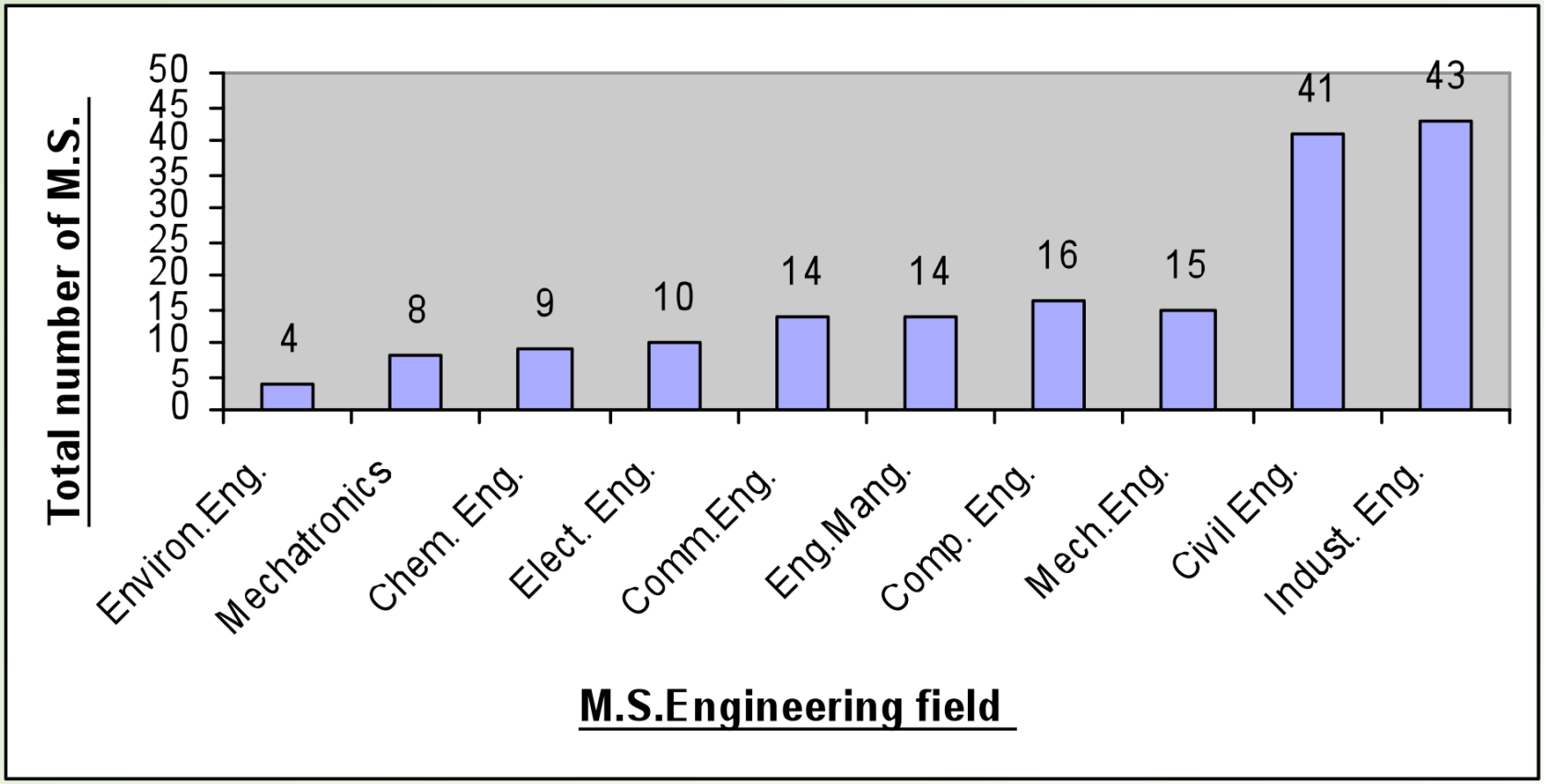
Distribution of B.S. Graduate Students in Engineering from Jordanian Universities by Field for the Year (2008 / 2009) (2)



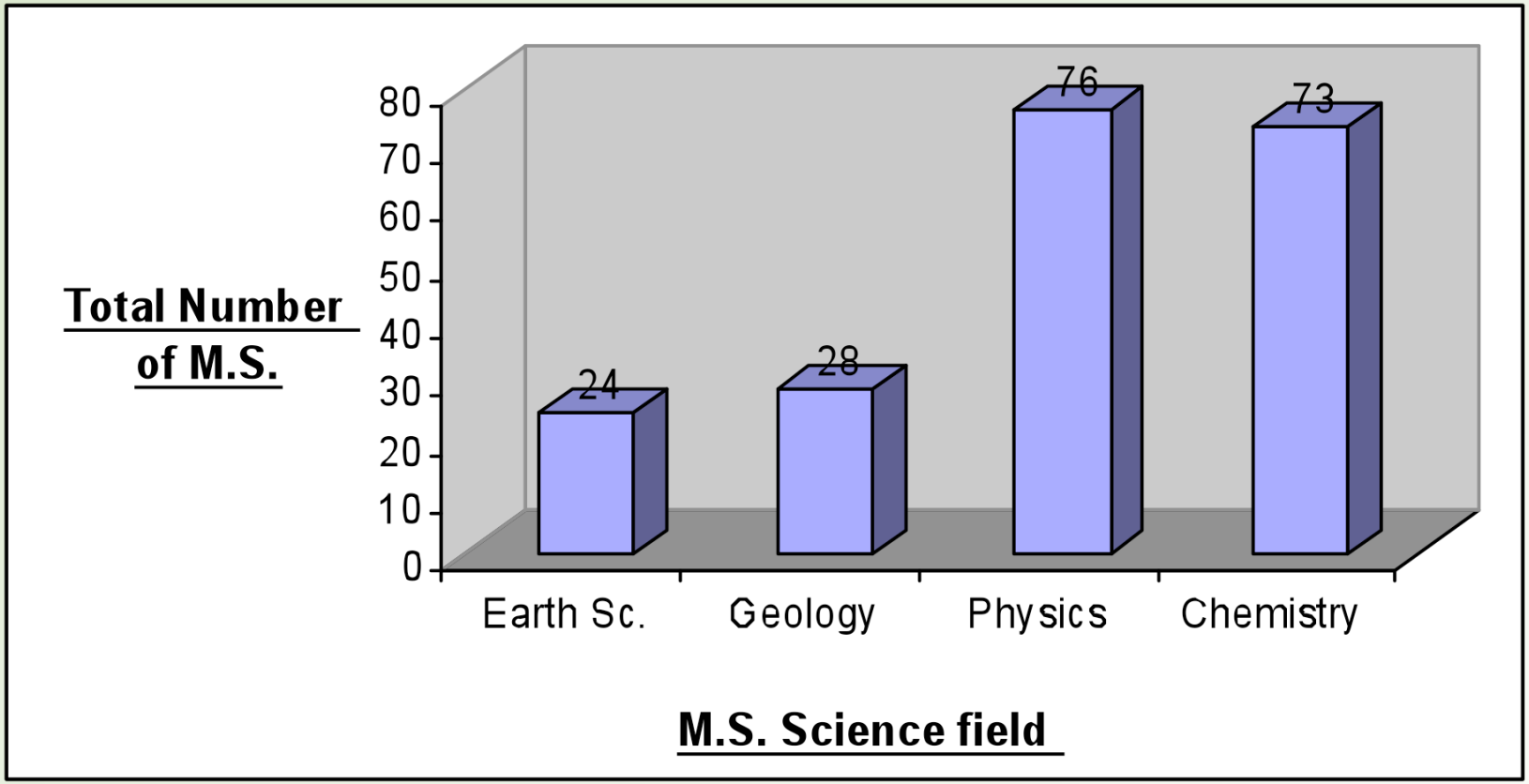
Distribution of B.S. Graduate Students in Natural Sciences from Jordanian Universities by Field for the Year (2008 / 2009)



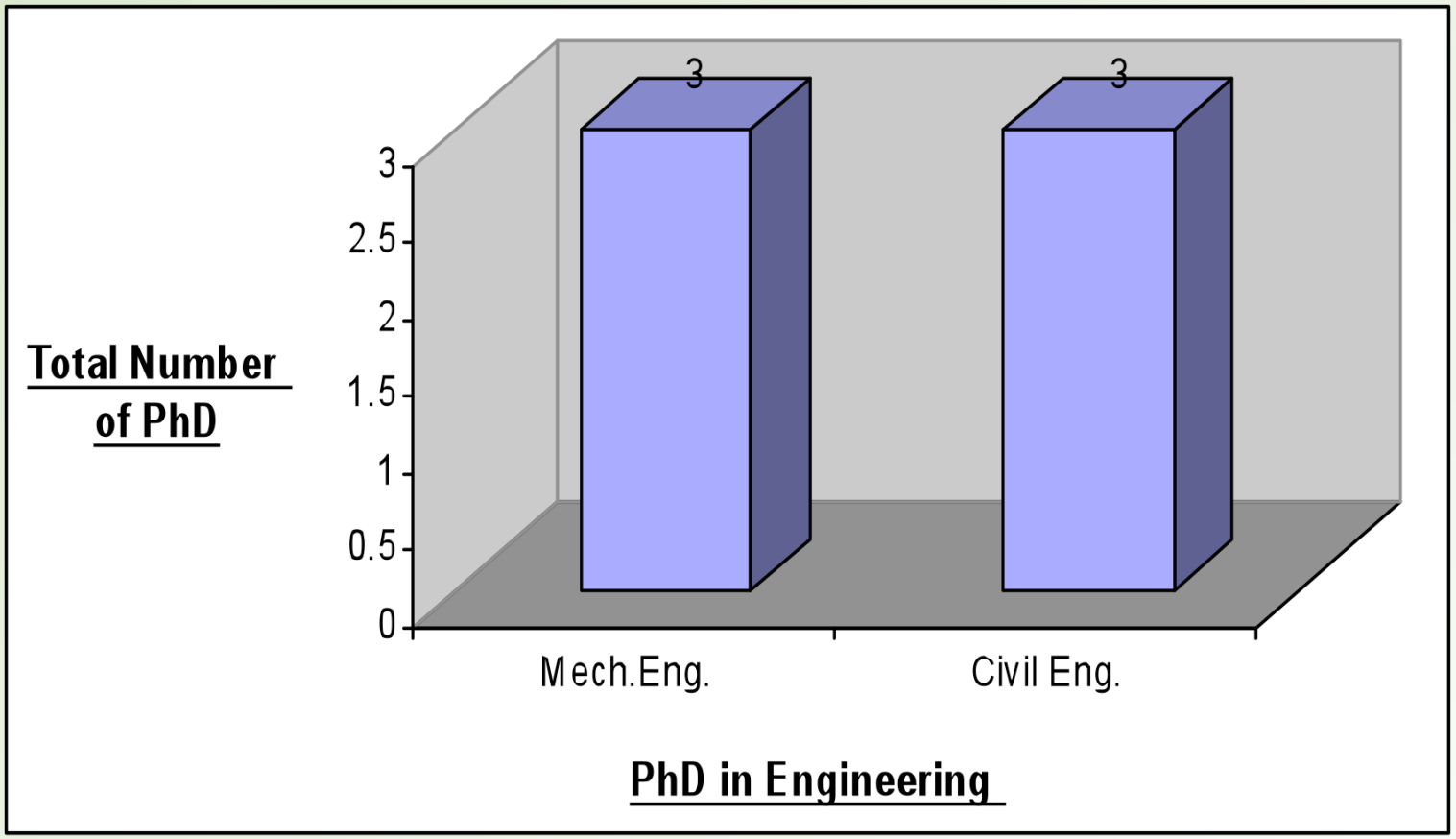
Distribution of M.S. Graduate Students in Engineering from Jordanian Universities by Field for the Year (2008 / 2009)



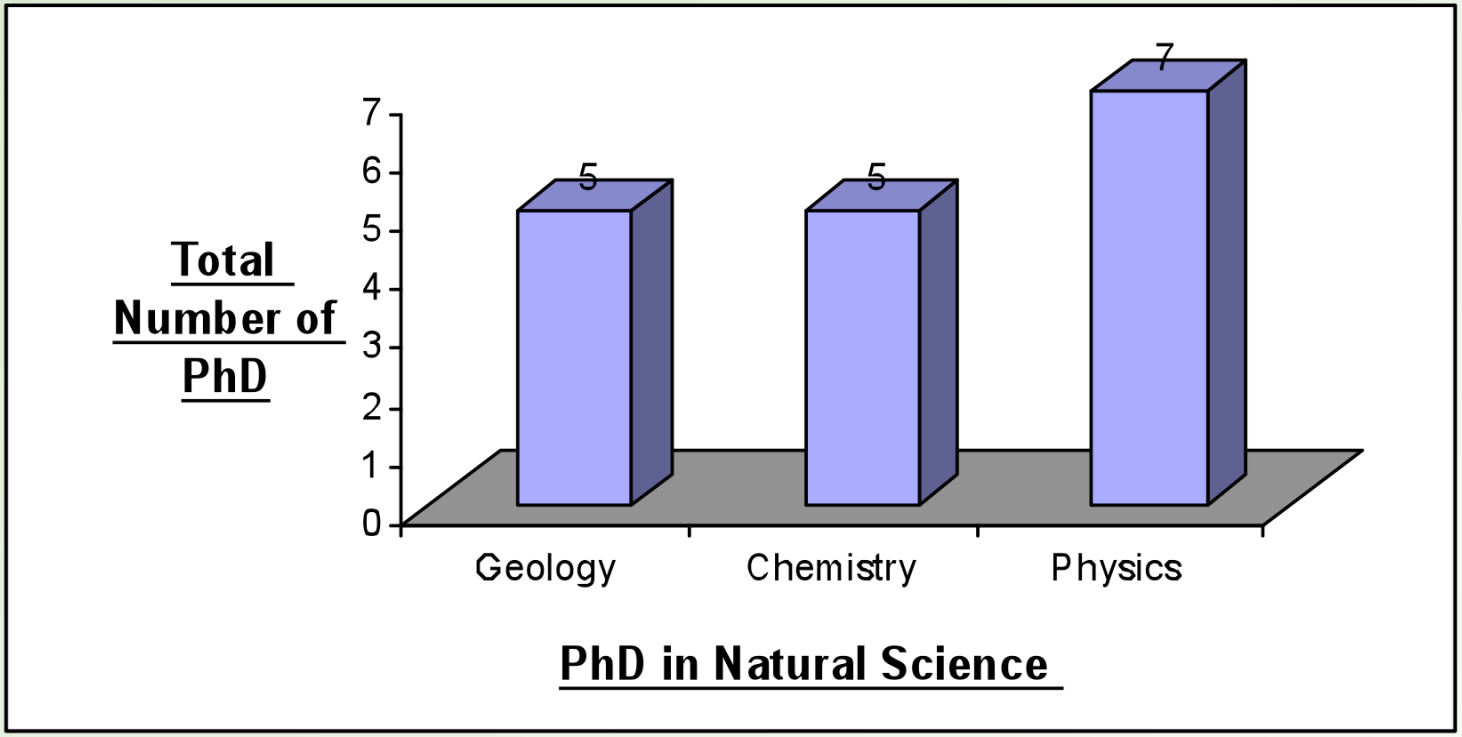
Distribution of M.S. Graduate Students in Natural Sciences from Jordanian Universities by Field for the Year (2008 / 2009)



Distribution of PhD Graduate Students in Engineering from Jordanian Universities by Field for the Year (2008 / 2009)



Distribution of PhD Graduate Students in Natural Science from Jordanian Universities by Field for the Year (2008 / 2009)



Nuclear Education at Jordanian Universities

University Name	Field	Degree
Jordan University	Nuclear Physics (2008) Medical Physics (2008)	M.S. M.S.
Jordan University for Science & Technology	Nuclear Engineering (2007)	B.S.
AL-Balqa Applied University	Nuclear Physics (2008)	M.S.

Nuclear Education Related Fields at Jordanian Universities

Field	Degree	University
Civil Eng., Chemistry, Physics	PhD	UJ
Civil Eng., Eng. Management,	M.S.	UJ, Mu'ta
Elect., Eng.	B.S., M.S.	UJ, JUST,YU, HU
Mech. Eng.& Mechatronics	B.S., M.S.	UJ, JUST
Industrial Eng.	B.S., M.S.	UJ, JUST, HU
Civil Eng.	B.S.	All Universities
Computer Eng.	B.S.	All Universities
Chemistry	B.S., M.S.	UJ, JUST,YU, HU,Mu'ta
Physics	B.S., M.S.	UJ, JUST,YU, HU,Mu'ta

The Planned Educational Programs

- Scholarships, fellowships and grants from JAEC, Jordanian universities and other institutions in Jordan are currently offered.
- Regional and international agencies such as SEASAME Centerand IAEA are offering scholarships in fields related to nuclear sciences.
- Design, implementation or upgrading of master degrees in nuclear engineering and management in Jordan universities.
- Postgraduate training in the best international institutes.
- Internship in international nuclear Industries.

Cooperation Modalities for HRD

- Scholarships
- Co-chaired PhD candidates
- Exchange of faculty members and students
- Joint R&D
- Internship for students in industry
- Twinning programmes
- Joint programmes with international institutions such that students spend part of the time in Jordan and the other abroad.
- Networking professors, scientists, and engineers in Jordan and other countries.

Main Fields for Scholarships & Training

- Nuclear Project Management
- Nuclear Reactor Physics
- Nuclear Power System
- Nuclear Safety and Security
- Nuclear Waste Management
- Nuclear Research Reactor Utilization
- Nuclear Fuel Cycle Management
- Nuclear Law

Scholarships in the Nuclear Fields

Country	Scholarships
France	5/yr
China	5/yr

Public Awareness

- To inform decision makers, planners, and national legislators in the government, utilities, press, public opinion leaders, and regulatory commission on NPP development and infrastructure issues
- About 10-20 hours of lectures and discussion
- Lessons from the French experience will be valuable and instructive

Conclusion

- Jordan is developing a civilian nuclear power programme for the benefit of the economy
- **Education and training** are one of the key factors for the success and sustainability of the programme
- International cooperation and support are vital for achieving the above

Thank You