SAND2016-7706C

# The Gulf Nuclear Energy Infrastructure Institute (GNEII)

*Nuclear Energy for the Gulf: Key Questions and Opportunities*
*Gulf Research Centre, University of Cambridge, United Kingdom*
*16-19 August 2016*

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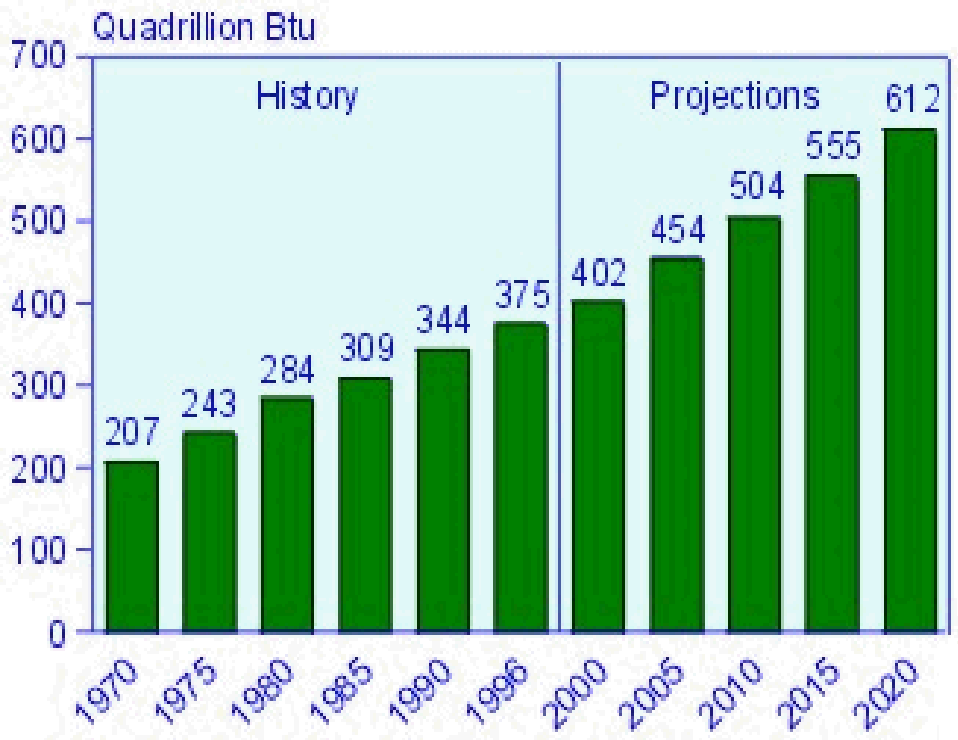
# Outline

- Introduction
- Institutional Overview
- Institutional Impact
- Phase II: Sustainability and Future
- Summary

# Introduction: Energy Demand

- Increase in global energy demand
- Utilization of energy from alternative sources must be increased
- Infrastructure and human resources must be developed




Global Energy Consumption and Projected Future Demand

Some researchers predict a 45% increase in the global energy consumption by 2030

# Global nuclear power enterprise

## Growth in new countries & new construction

**Global Scan:**

1. **Operating reactors – 432**
2. **Reactors under construction – 68**
3. **Reactors planned – 162**
4. **Reactors proposed – 316**
5. **Nuclear energy generation capacity (2012) – 2346 billion kWh**

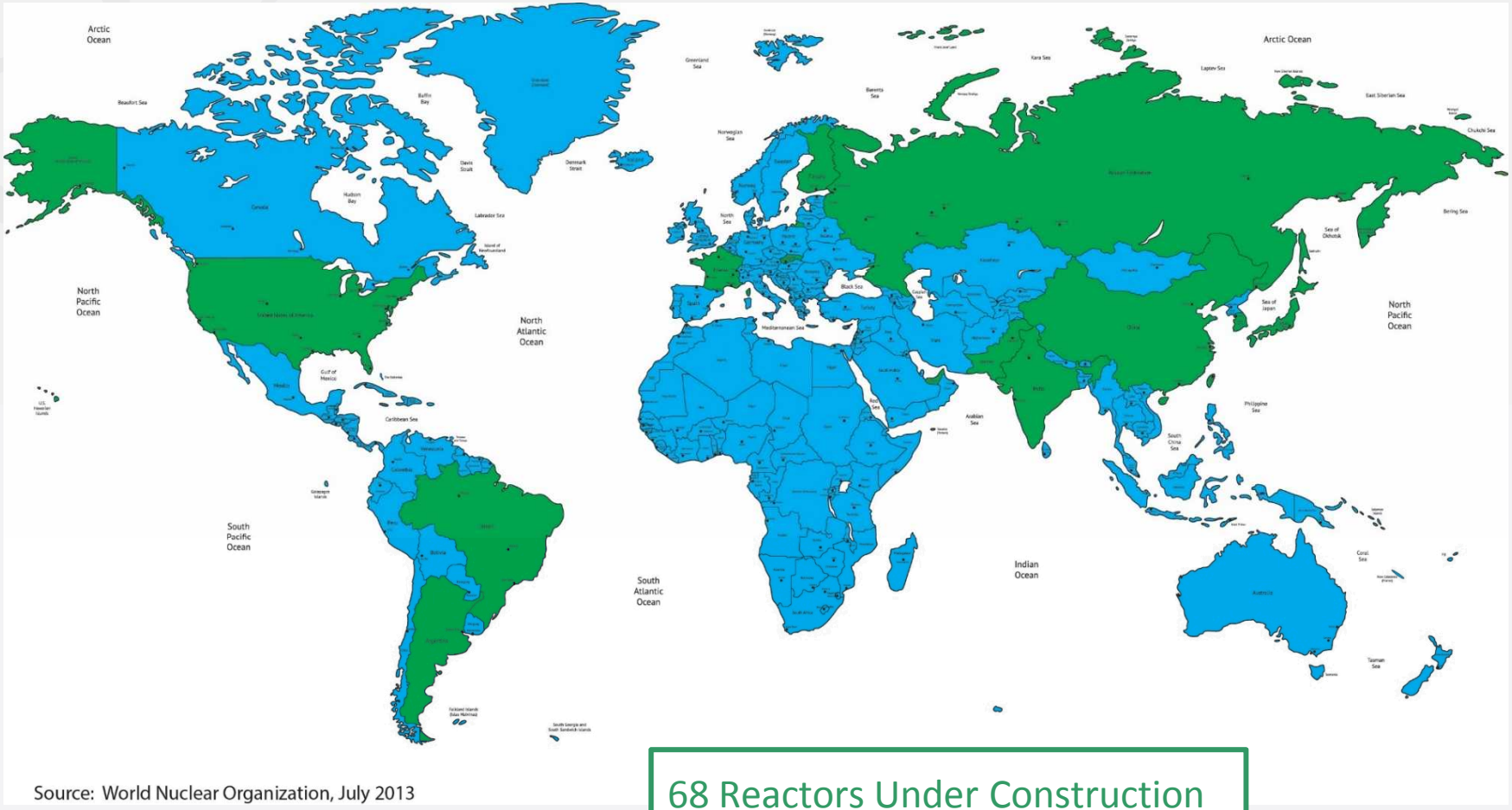
***Countries planning to build nuclear power plants for the first time:***

**Bangladesh, Belarus, Chile, Egypt, Indonesia, Israel, Italy, Jordan, Kazakhstan, North Korea, Lithuania, Malaysia, Poland, Saudi Arabia, Thailand, Turkey, UAE, and Vietnam.**

# Countries with operating reactors


432 Operational Reactors
30 Countries

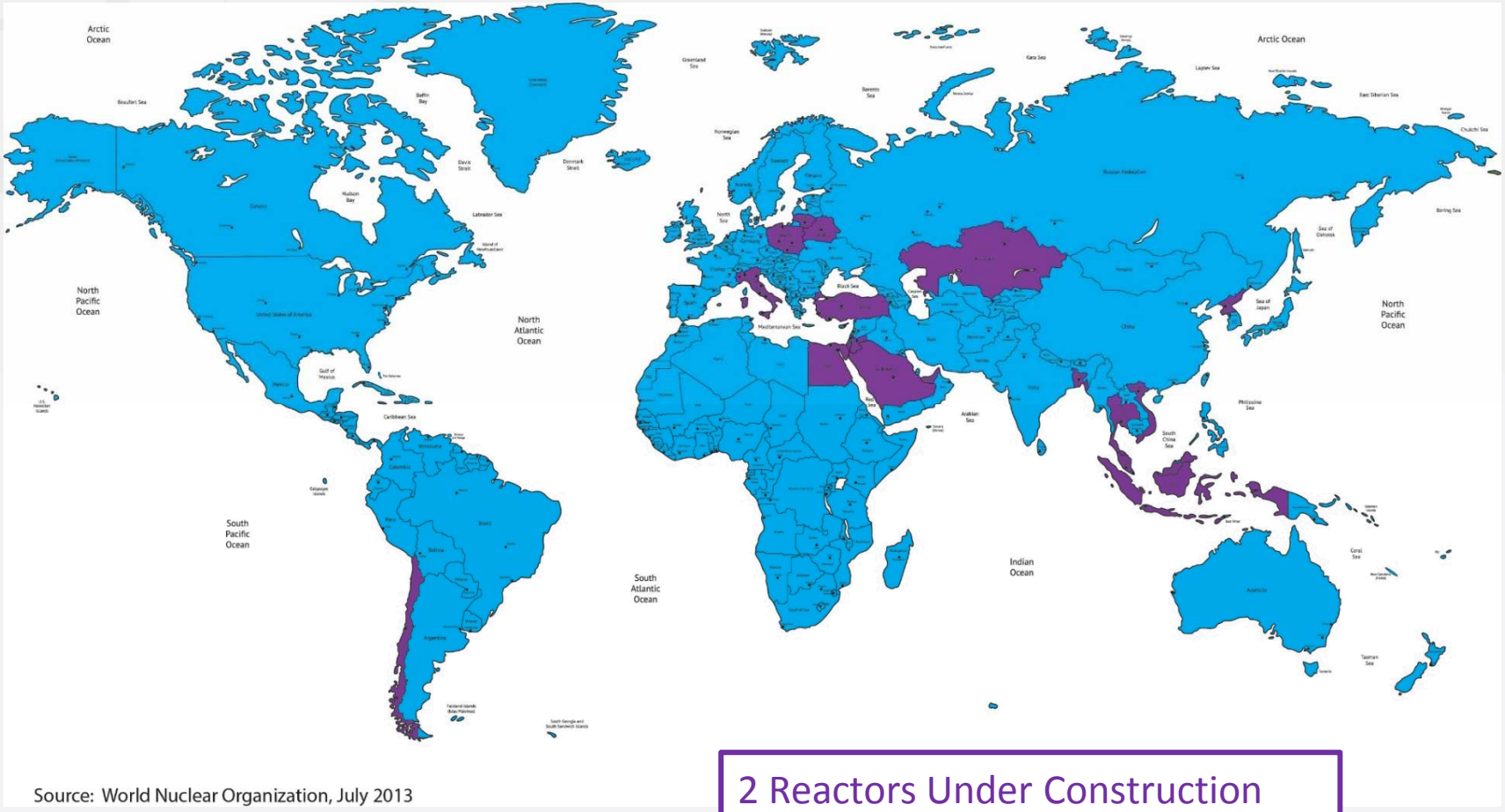
# Countries with reactors under construction




Source: World Nuclear Organization, July 2013

68 Reactors Under Construction
13 Countries

# Countries building, planning, or proposing nuclear reactors for the first time




Source: World Nuclear Organization, July 2013

2 Reactors Under Construction
27 Reactors Planned
68 Reactors Proposed
18 Countries

# Responsible Nuclear Energy Development

- Safe, Secure, and Safeguarded
- Regional need for educational, human, and technical resources necessary to develop a responsible nuclear energy infrastructure
- Need to develop an indigenous nuclear safety, security and safeguard (3S) culture
- Need for institutional capability to couple nuclear energy security, safeguards, and safety with nuclear energy infrastructure development and education

# Brief History

- Initial Discussions
- International Consultations
- Regional Scoping Trip

**2009**

**2010 -2011**

- Letter of Intent
- Memorandum of Understanding
- GNEII Pilot Course
- International Conferences

- Fundamentals Course
- International Conferences
- GNEII Symposium

**2012 -2016**

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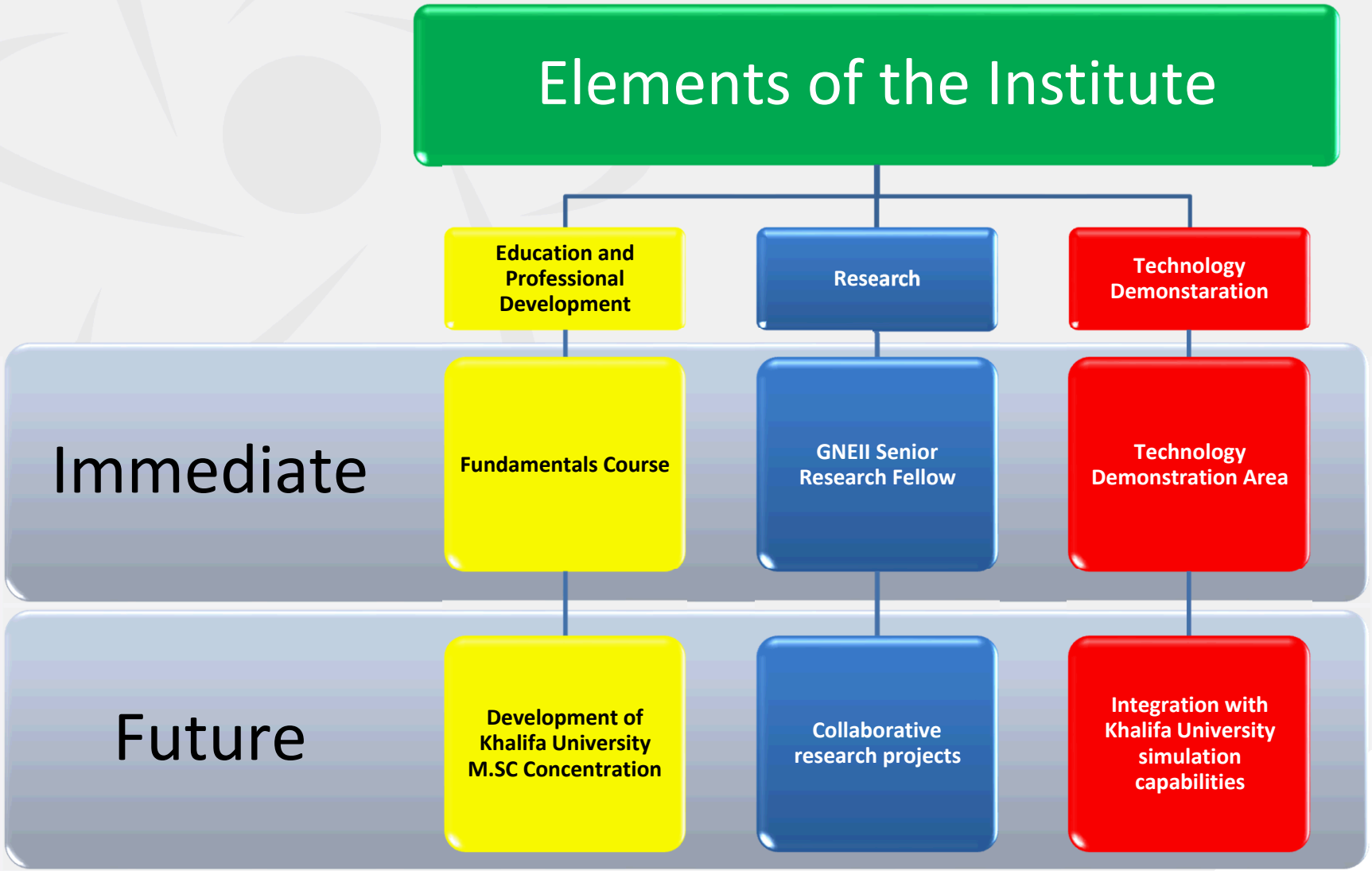
# Gulf Nuclear Energy Infrastructure Institute (GNEII)

- GNEII is:
  - A Gulf/Middle east regional human resource development capability
    - Hosted at Khalifa University, Abu Dhabi, UAE
  - A strategic partnership
    - Between UAE (KU, CICPA, ENEC, FANR) & U.S. (DOE/NNSA, DOS/PNS, SNL & TAMU,) stakeholders
  - An educational & research entity
    - Beyond traditional training courses
  - A leader in '3S' & emergent nuclear energy infrastructure knowledge

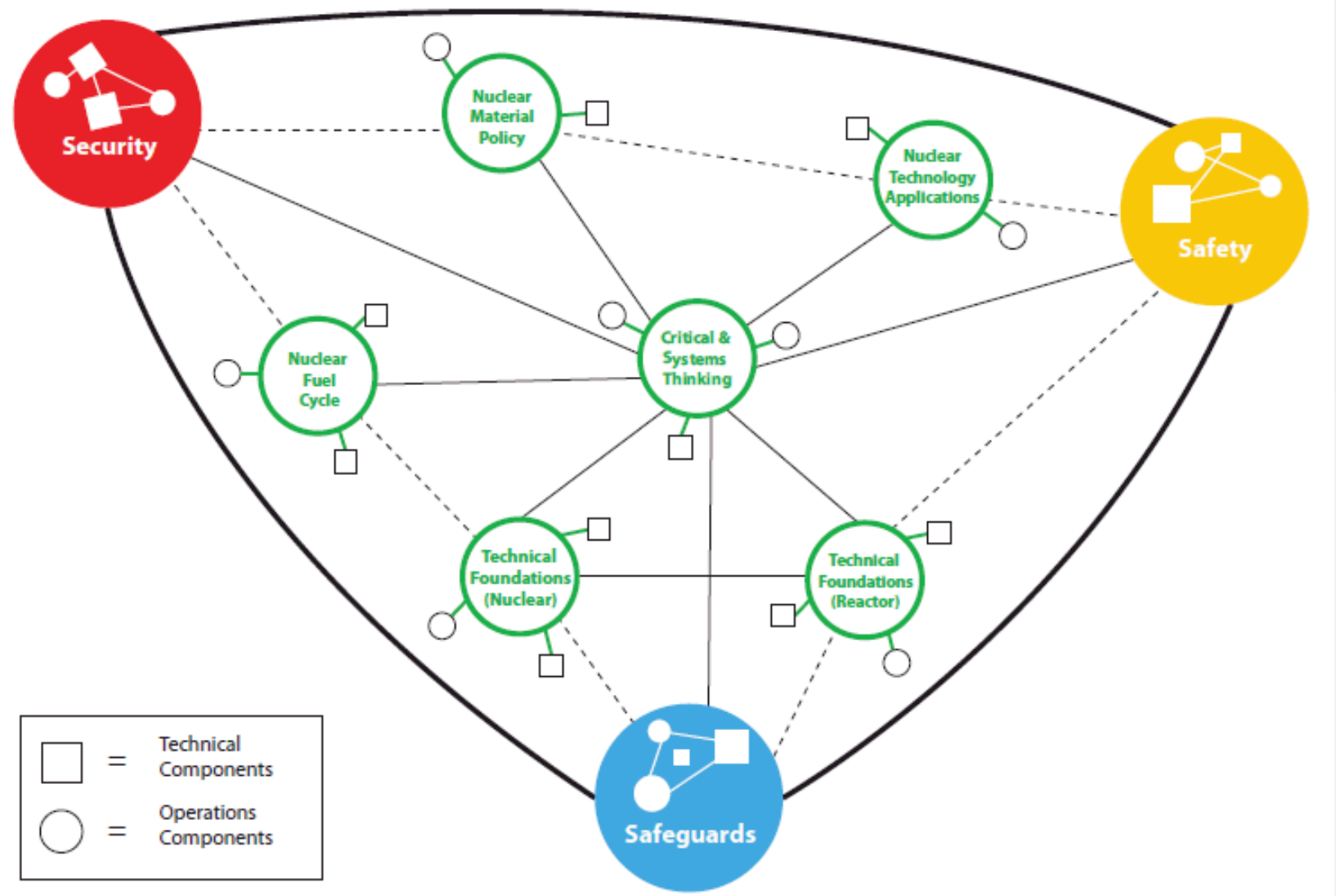
# Introduction & Background

- GNEII's Mission:
  - to develop a responsible nuclear energy culture and institutionalize key safety, safeguards, security, and nonproliferation norms in the future decision-makers of Gulf-region nuclear energy programs through professional development
- GNEII's Vision:
  - provide the Gulf, and surrounding region, with a continual source of indigenous nuclear energy professionals with whom the global community can effectively collaborate to achieve broader nuclear energy security, safeguards and safety priorities
- Established in 2011, 5 years of operation

# Foundational Pillars

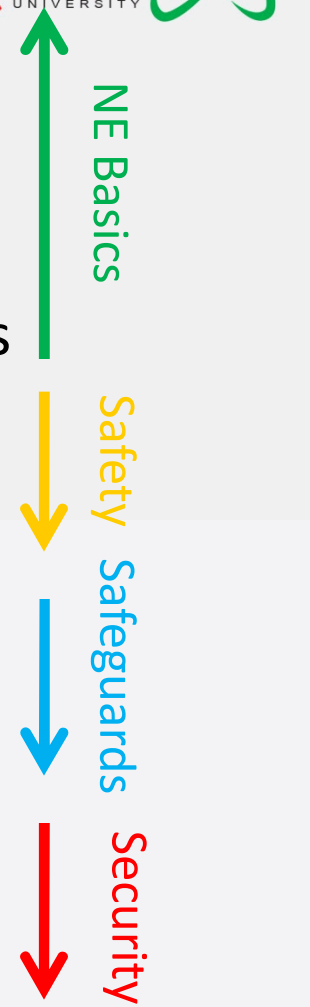


# Fundamentals Course Elements



# Fundamentals Course Syllabus

1. Critical Thinking, Systems Analysis, Scientific Method
2. Basic Nuclear and Reactor Physics
3. Nuclear Power Plant Management and Operations
4. Nuclear Fuel Cycle History, Policy and Technical Issues
5. Nuclear Safety: Reactor Safety Systems
6. Accident Modeling and Emergency Preparedness
7. Nuclear Safeguards: Terminology, Technology, Systems, and Measurement
8. Nuclear Safeguards: Introduction to Applications
9. Nuclear Security: Physical Protection Design, Implementation and Evaluation
10. Nuclear Security: Vulnerability Assessment for Nuclear Facilities
11. **Capstone Projects**



# Pilot Course: Spring 2011

# Fundamentals Course Graduates

- Regional/international support
  - MESIS, RMCC, IAEA
- Regional participation
  - Interest from Bahrain, Oman, Jordan, Egypt, and Morocco in 2016

| Year | # UAE Fellows | | | # Non-UAE Fellows | Yearly Total | Countries Represented |
|---|---|---|---|---|---|---|
| | ENEC | FANR | CICPA | | | |
| 2011 | 4 | 5 | 1 | 0 | 10 | UAE |
| 2012 | 3 | 9 | 2 | 8 | 18 (22)[i] | UAE, Kuwait, Saudi Arabia, Qatar, Jordan |
| 2013 | 4 | 6 | 3 | 7 | 20 | UAE, Saudi Arabia, Qatar |
| 2014 | 6 | 3 | 3 | 0 | 12 | UAE |
| 2015 | 7 | 4 | 5 | 2 | 18 | UAE, Jordan |
| 2016 | 2 | 16 | 3 | 0 | 21 | UAE |
| **TOTAL** | **26** | **43** | **17** | **17** | **99** | **5** |

[i]Due to modular structure of the course in 2012 not all international participants were able to finish all required modules due to logistical complications.

# Capstone Projects

- increasingly challenging problems facing host organizations
- 5 of 8 projects directly from ideas suggested by the UAE stakeholders
- 3 projects involved experiments

| 2016 Capstone Project Title | Author Host Organization(s) |
|---|---|
| **Review of Accident Tolerant Fuel Concepts for Light Water Reactors – A Qualitative Assessment of Current Technology** | ENEC/FANR |
| **Evaluation techniques for degradation of reactor containment building** | FANR |
| **Evaluation of Cosmic-Ray Dose in the UAE** | FANR |
| **Measurements of radionuclides concentration in UAE cucumber** | FANR |
| **Safeguards and Security approach to final spent fuel repository** | FANR |
| **Mitigation of national cultural differences effects during safety, security emergency at an NPP site** | FANR |
| **Neutron activation of living insects for safety and security applications** | FANR |
| **Development of nuclear security exercises at a Nuclear Power Plant** | CICPA |

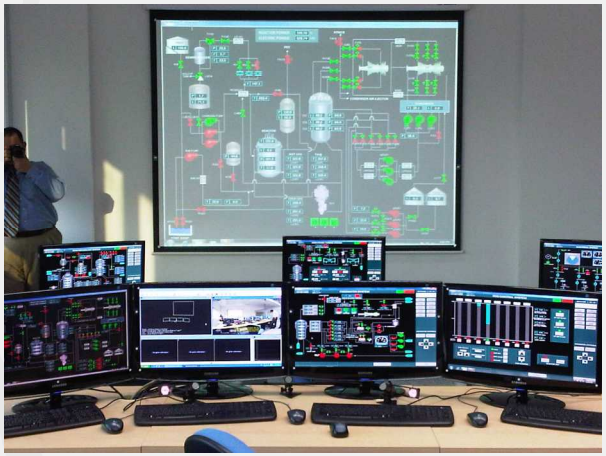
ENEC = Emirates Nuclear Energy Corporation (UAE); FANR = Federal Authority for Nuclear Regulation (UAE); CICPA (formerly CNIA) = Critical Infrastructure & Coastal Protection Authority (UAE)

# Research Pillar

- Publications about GNEII
  - INMM: 2010, 2011, 2012, 2013, 2015, 2016
  - CONTE: 2013, 2015
  - ANS: 2015
  - APS Forum on International Physics: 2015
- Publications by GNEII
  - INMM 2012: Fellow Capstone project
  - *Nuclear Engineering & Technology* (2015)
  - INMM 2015: NaIGEM analysis
  - *Health Physics Journal* (2016)
  - *IAEA International Security Conference* (2015)-poster submission
  - *International Journal of Sustainable Water & Environmental Systems* (2016)

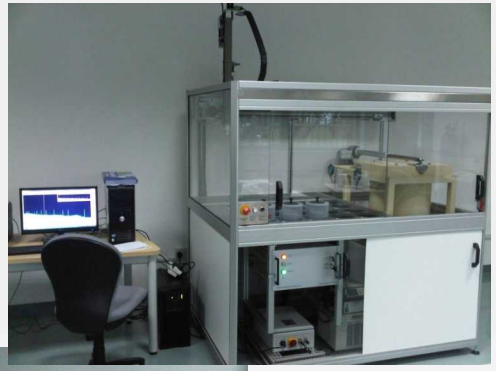
# Technology Demonstrations

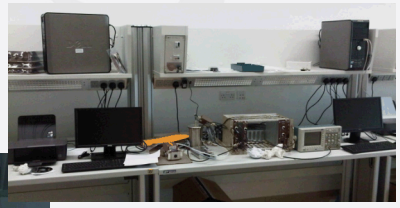
Scale Model of APR 1400 Reactor Pressure Vessel



Reactor Analysis, Design and Instrumentation Controls Lab

Environmental Radiation Lab





Radiation Sciences Lab

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# Institutional Impact

- Testimonies from the Fellows:
  - *'GNEII is a remarkable experience…[and] very valuable to start my career'*
  - *'GNEII is a unique course for beginners in nuclear sector'*
  - *'GNEII is not just a training course that you add to your CV…It is a very powerful educational tool that changes your perspective'*
- Testimonies from the Stakeholders:
  - *FANR Director of Education & Training:*
    - *'The GNEII program is one of the major milestones in the career development of FANR Engineers as it provides them with the fundamentals they need to gain an overall understanding on the concept of safety, security and safeguards.'*
  - *Chairman of GNEII Steering Committee:*
    - *'I'm confident that this innovative program will continue to grow and attract the brightest minds in nuclear engineering from around the region and the world, while supporting the countries goals for safe and secure nuclear energy in the UAE'*

# Institutional Impact

- GNEII in the literature:
  - Described by the Brookings Institute as:
    - A model for a regional training center for nuclear power program sustainability (2011)
    - Playing a key role in developing the UAE's nuclear power program (2012)
  - Described by the Stanley Foundation as:
    - An example of recognizing the importance of an integrated approach to security, safety and safeguards for nuclear projects (2012)
  - In various journals, including:
    - *Middle East Policy, Alternative Energy in the Middle East, Journal of Arabian Studies, The Arab Gulf States Institute in Washington, Security Index: A Russian Journal on International Security, Renewable and Sustainable Energy Reviews, Asian Affairs and Energy Policy*

# Phase II: Sustainability & the Future

- Phase II officially launched with the signing of a 'MOU 2.0' between Khalifa University, Sandia National Laboratories & NSSPI of the Texas A&M University System
  - entitled 'Establishing a Framework for Continuing Collaboration with the Gulf Nuclear Energy Infrastructure Institute (Sandia MOU Number 16-2-706).'

- MOU 1.0 focused on outlining the collaboration to develop and operate GNEII

- MOU 2.0 emphasizes the evolution and expansion of peer-to-peer collaboration across the institute's foundational pillars

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# Phase II: Sustainability & the Future

- Research Pillar
  - **MOU 2.0** provides a strong foundation on which to expand current institute research efforts
  - **Short-term goal:** to build up GNEII's research capability & generate a corpus of work demonstrating GNEII's research ability
  - **Long-term goal:** to generate, apply for and complete joint research proposals to explore issues within GNEII's research framework and contribute to the global discourse on nuclear energy issues

تفاهم بين جامعة خليفة ومؤسسات أميركية

أبوظبي (الاتحاد)

اختتمت أمس جامعة خليفة في حرمها بأبوظبي الدورة الخامسة لمؤتمر معهد الخليج للبنية التحتية للطاقة النووية، بتخريج 21 طالبا وطالبة من المهنيين، وتوقيع مذكرة تفاهم مع كل من مختبرات «ساندیا» الوطنية الأميركية ومعهد علوم وسياسات الأمن النووي التابع لجامعة «تكساس أي آند إم» الأميركية، تنص على استمرار التعاون بين الشركاء الثلاثة.

وقد شهد المعهد منذ تأسيسه في عام 2011 تخريج ما مجموعه 99 من الخبراء والعاملين في مختلف القطاعات ذات الصلة من كل من دولة الإمارات والسعودية وقطر والكويت والأردن، حيث زودتهم الدورة بمهارات متقدمة وفهم معمق في مجالات الأمن والحماية والسلامة النووية. وسيشهد التعاون بين جامعة خليفة ومختبرات «ساندیا» وجامعة «تكساس أي آند إم»، تبادلا للخبرات بين الشركاء الثلاثة في نظم الطاقة النووية والبرامج والإشعاع والنمذجة البيئية وتطوير البنية التحتية للطاقة النووية والأمن النووي والسلامة النووية، وتطوير المناهج الدراسية في مجالات الأمن والمعلومات، وتطوير البنية التحتية النووية في منطقة الخليج والشرق الأوسط.

شهد التخريج كل من السفير حمد الكعبي المندوب الدائم للدولة لدى الوكالة الدولية للطاقة الذرية، وباربرا ليف سفيرة الولايات المتحدة الأميركية لدى الدولة، وآن هارينغتون، نائب مدير قسم عدم الانتشار النووي في الإدارة الوطنية للأمن النووي في وزارة الطاقة الأميركية، بالإضافة إلى الدكتور تود لارسن، رئيس جامعة خليفة، والدكتور عارف سلطان الحمادي، مدير جامعة خليفة.



خلال توقيع مذكرة التفاهم (من المصدر)

# Phase II: Sustainability & the Future

- Educational Pillar

Modify previous Fundamentals Course curricula & course materials into a new modularized format aligned with Khalifa University course structures.

- **Graduate Certificate:** a summer session covering the fundamentals of nuclear energy systems, critical thinking and systems approaches to nuclear energy;
- **Advanced Certificate:** completion of additional graduate courses in nuclear safety, security and safeguards during KU's normal fall and spring semesters;
- **Masters Degree:** completion of above plus a graduate-level thesis project.

# Phase II: Sustainability & the Future

- Technology Services Pillar
  - Transition from 'Technology **Demonstration**' → Technology **Services**'
  - Redefinition includes:
    - providing targeted training classes for Emirati or regional nuclear energy organizations
    - hosting international or regional events & conducting support analysis
  - Examples:
    - Technical reach-back to Khalifa Port in Abu Dhabi for evaluating alarm data from their HPGE radiation portal monitors
    - KU/GNEII successfully hosted Department of State/Partnership for Nuclear Security sponsored workshops on
      - Nuclear Security Curriculum Development (2013)
      - Nuclear Security Incident Root Cause Analysis: Methods, Tools, & Best Practices (2014)
    - KU/GNEII hosted Tenth Annual meeting of the Radiation Measurement Cross Calibration network

# Summary

- **GNEII Phase I**: U.S. & UAE stakeholders, sponsors and implementers established an educational and research institute that is already positively impacting nuclear energy programs in the Middle East and Gulf regions

- **GNEII Phase II**: Leverage the institute's strong reputation and current momentum to
  - continue to produce high-performing graduates
  - evolve and expand its research capabilities
  - Increase publications to enhance the prominence of regional perspectives and insights in nuclear energy discussions

- GNEII is primed for a strong transition to Emirati ownership & continue toward its mission of becoming a leading entity through which Gulf and Middle East voices can be introduced into global nuclear discourse

# Thank You

- For more information or to nominate GNEII Fellows, please contact:
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