Nuclear Energy in the Middle East: Challenges and Opportunities

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BEIRUT, LEBANON

Nuclear Energy Density

1 UO_2 Pellet (7 g)

=

850 Kg of coal

150 Gallons of oil

17,000 cubic feet of NG

Nuclear Power in a Nutshell

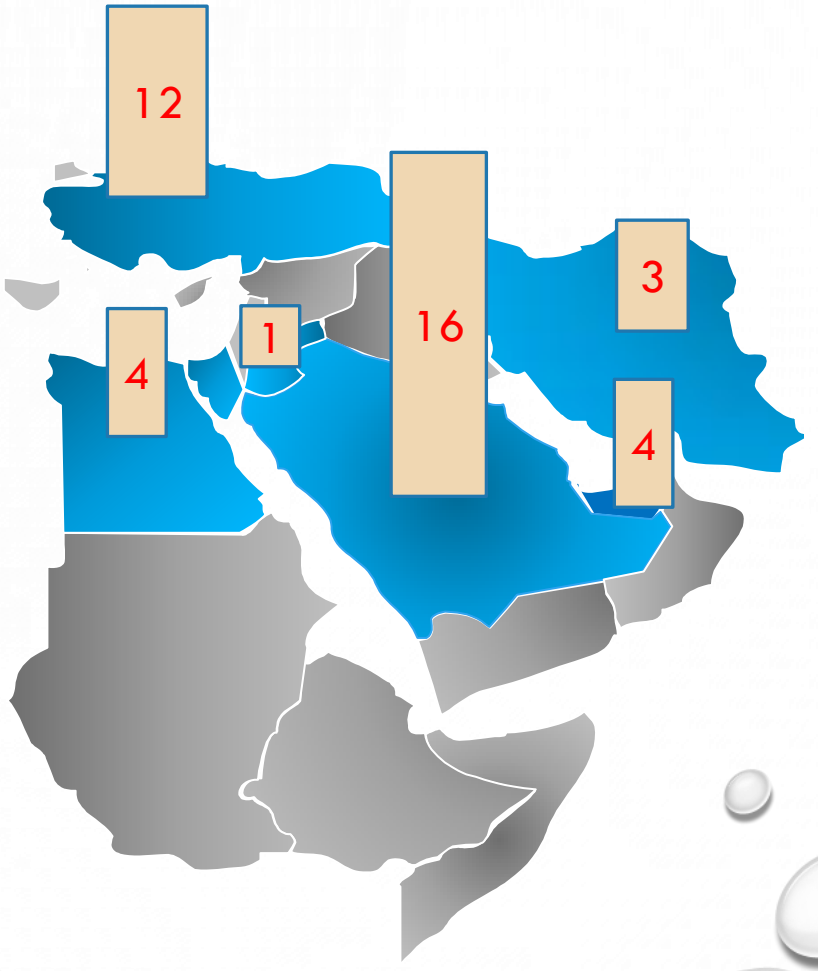
- 450 operating reactors (401 GWe)
- 56 reactors under construction (61 GWe))
- 111 reactors planned (122 GWe)
- 10% of world's electricity production in 2018 (2,563 TWh)
- Nuclear Fuel Requirements: 65,000 T/yr. of Uranium (RAR= 5.3 MT @130 $/Kg)
- By 2035: 140 reactors closing – 224 reactors coming on line

Barakah Nuclear Power Plant

Data Source: WNA Report World Nuclear Power Reactors and Uranium Requirements – June 2019

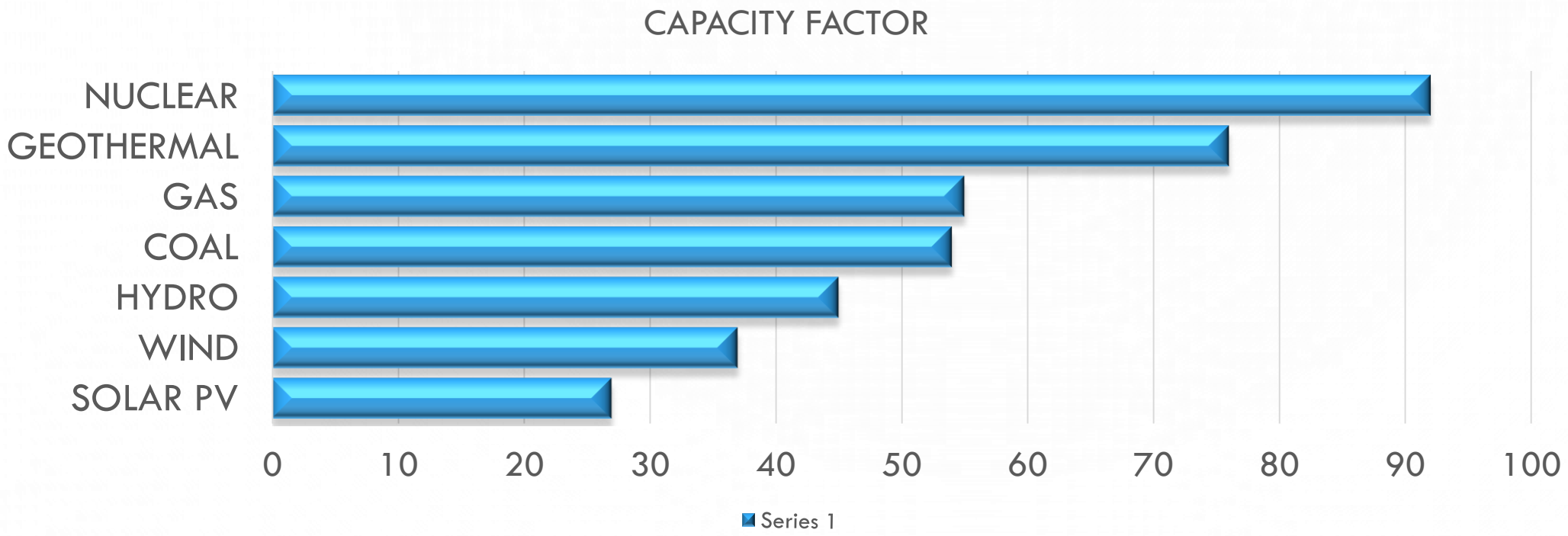
Nuclear Power Projects in the ME

	Operating		Under Construction		Planned		Proposed	
	No	Mwe	No	Mwe	No	Mwe	No	Mwe
Egypt	0		0		4	4,800	0	
Jordan	0		0		0		1	1,000
Saudi Arabia	0		0		0		16	17,000
UAE	0		4	5,600	0		0	
Turkey	0		1	1,200	3	3,600	8	9,500
TOTAL	0	0	5	6,800	7	8,400	25	27,500



WNA Report: World Nuclear Power Reactors and Uranium Requirements – June 2019

GENERATION CAPACITY FACTOR IN THE US (2017)



Greenhouse Gas Emissions and Nuclear Power

	Average Lifecycle GHG Emissions	Emissions for 2,563 TWh
	(T/GWh)	Million T of CO2
Lignite	1054	2,701
Coal	888	2,276
Oil	733	1,879
Natural Gas	499	1,278
Solar PV	85	218
Nuclear	**29**	**74**
Hydroelectric	26	67
Wind	26	67

WNA Report: Comparison of Lifecycle GHG Emissions of various Electricity Generation Sources – July 2011

Costs and Commitments

- Building an infrastructure
- High front-end and back-end costs
- Long construction time (10-15 years)
- Long commitment to technology (>100 years)
- Strong commitment to the culture of nuclear safety
- Ensuring physical plant protection and cybersecurity
- Managing used fuel and other radioactive waste

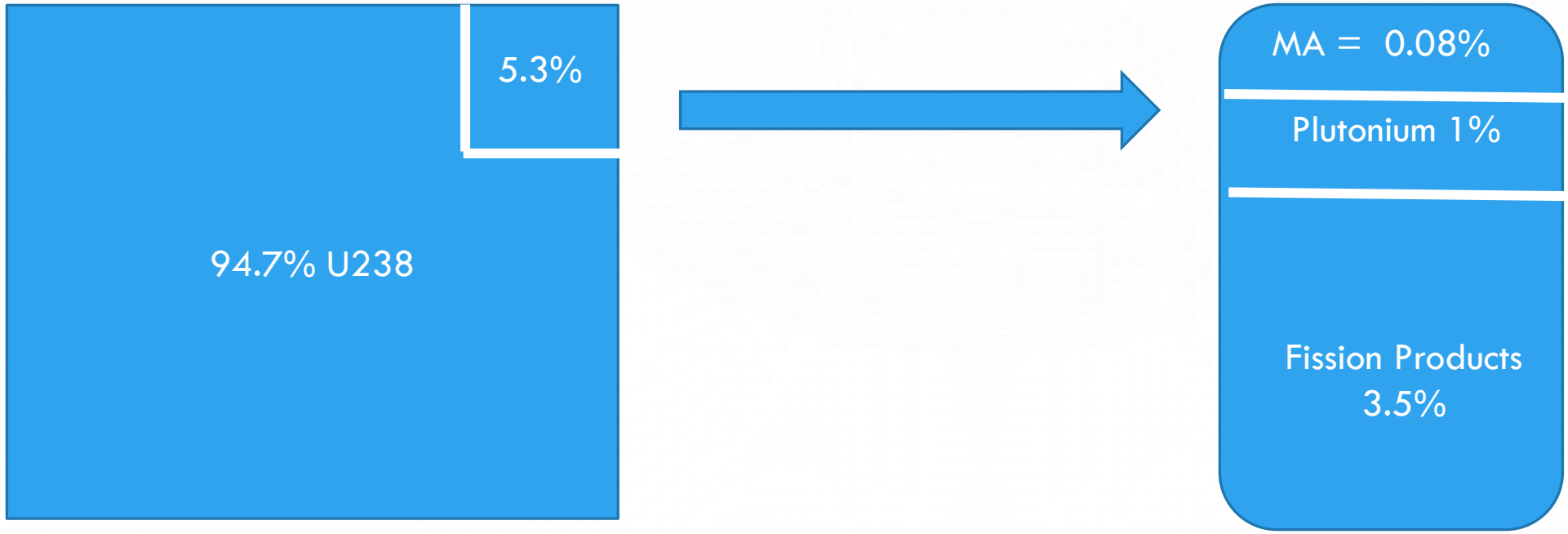
Commitment

Potential Areas for Regional Nuclear Cooperation

- Technical support for regulatory authorities
- Radioactive waste treatment and disposal
- Applied R&D, pilot evaluations and special investigations
- Training Institute: for skills and knowledge
- Operational feedback: Data analysis and lessons learned exchange.
- Quality Assurance Program
- Insurance Policies (against nuclear accidents)

Background slides

Used Fuel: Waste Characterization



Nuclear Waste

For a typical 1000 Mwe reactor:

- Electricity Production = 8 TWh
- 800,000 to 1,000,000 people
- Low level waste : 250 - 450 m^3/yr.
- High Level waste: 12 – 20 m^3/yr

- ❑ High Level Waste/cap. = 12 – 25 cm^3/yr. (the size of a cigarette)
- ❑ Low Level Waste/cap. = 250 – 560 cm^3/yr (the size of two cigarette boxes)

Historical Background

Gulf Cooperation Council

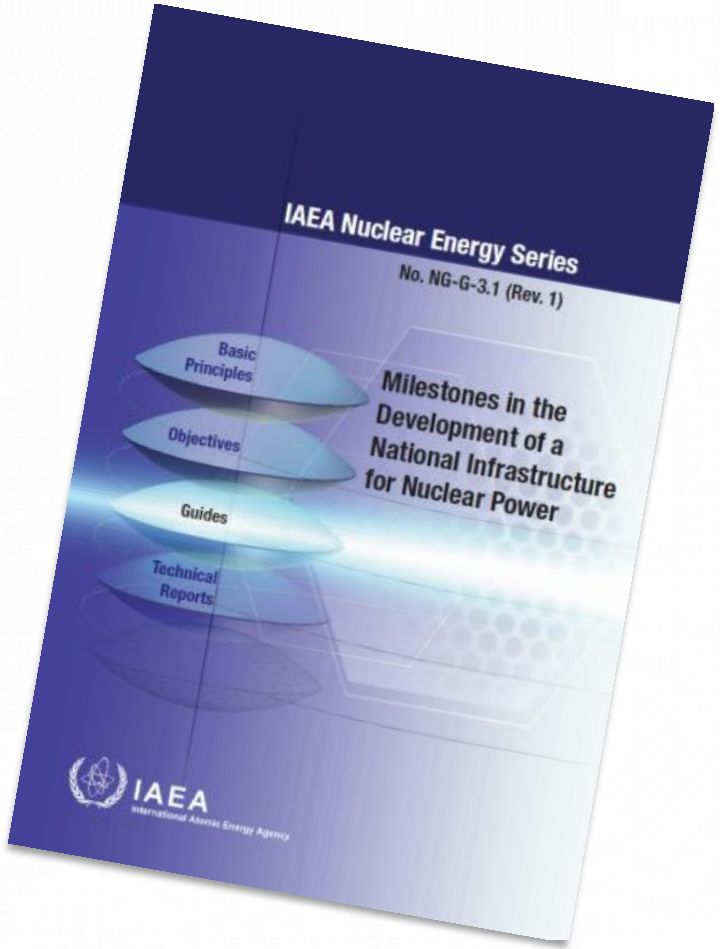
- 2006: GCC commissioning study on the peaceful use of NP
- 2007: the six States agreed to cooperate on a regional nuclear power and desalination program
- 2008: GCC appoints ambassador to IAEA (the six nations are all signatories of the NPT since 2003)
- 2008: UAE publishes comprehensive policy on nuclear energy
- 2012: UAE starts construction of 4 units (Barakah)

Egypt

- 1955: Egyptian Atomic Energy Authority is set up
- 1961: vintage 2 MWt research reactor at inshas
- 1983: El Dabaa site selected – but later dropped after Chernobyl accident (1986)
- Several false starts between 1976 and 2015
- 1997:(ETRR-2: 22 MWt research reactor from Argentina starts operation
- 2015: Intergovernmental agreement signed between Egypt and Russia for construction of 4 units
- 2019 (April): site approval permit for El Dabaa

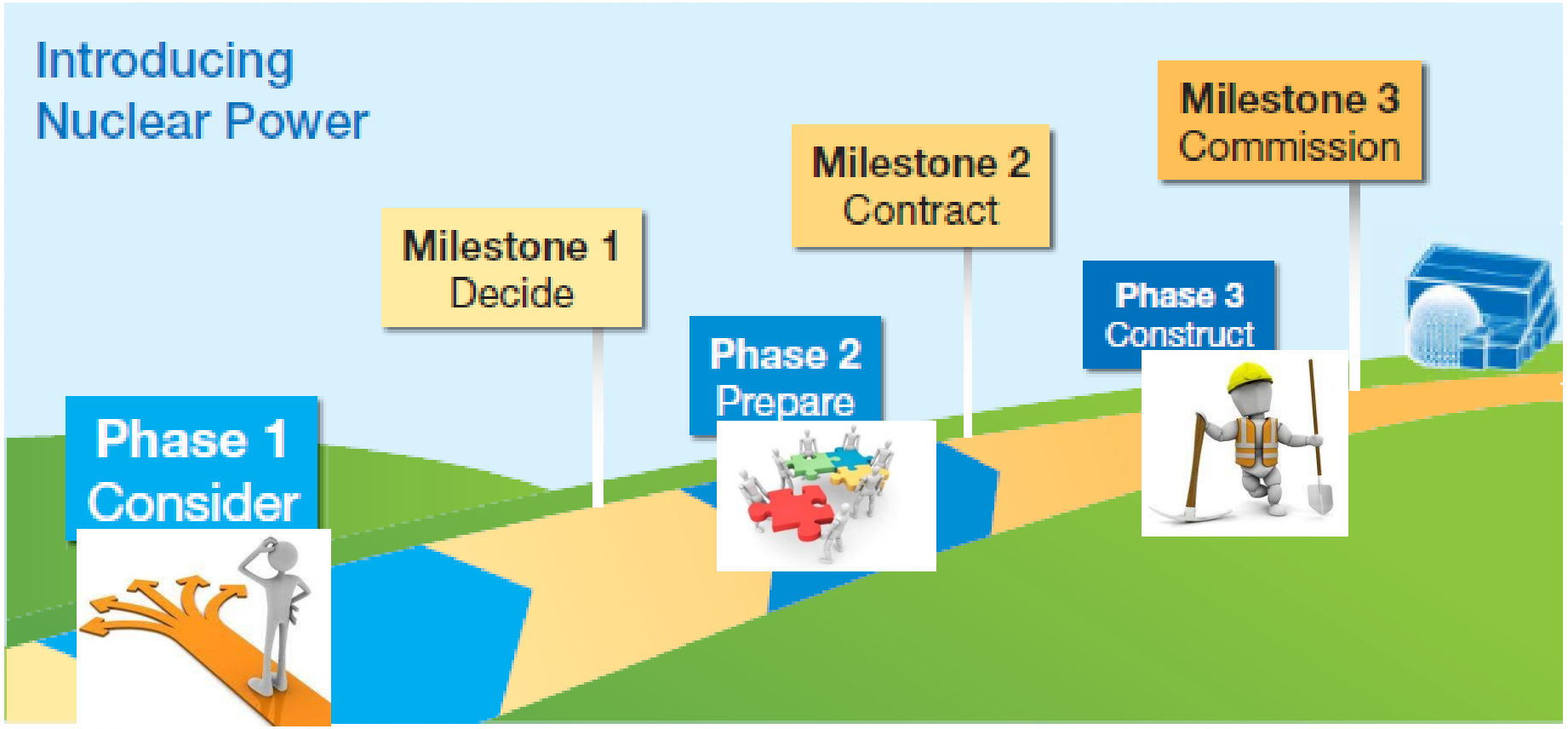
The IAEA Milestones Approach for Nuclear Power Infrastructure Development

- **Phased**
- **Comprehensive**
- **Integrated**



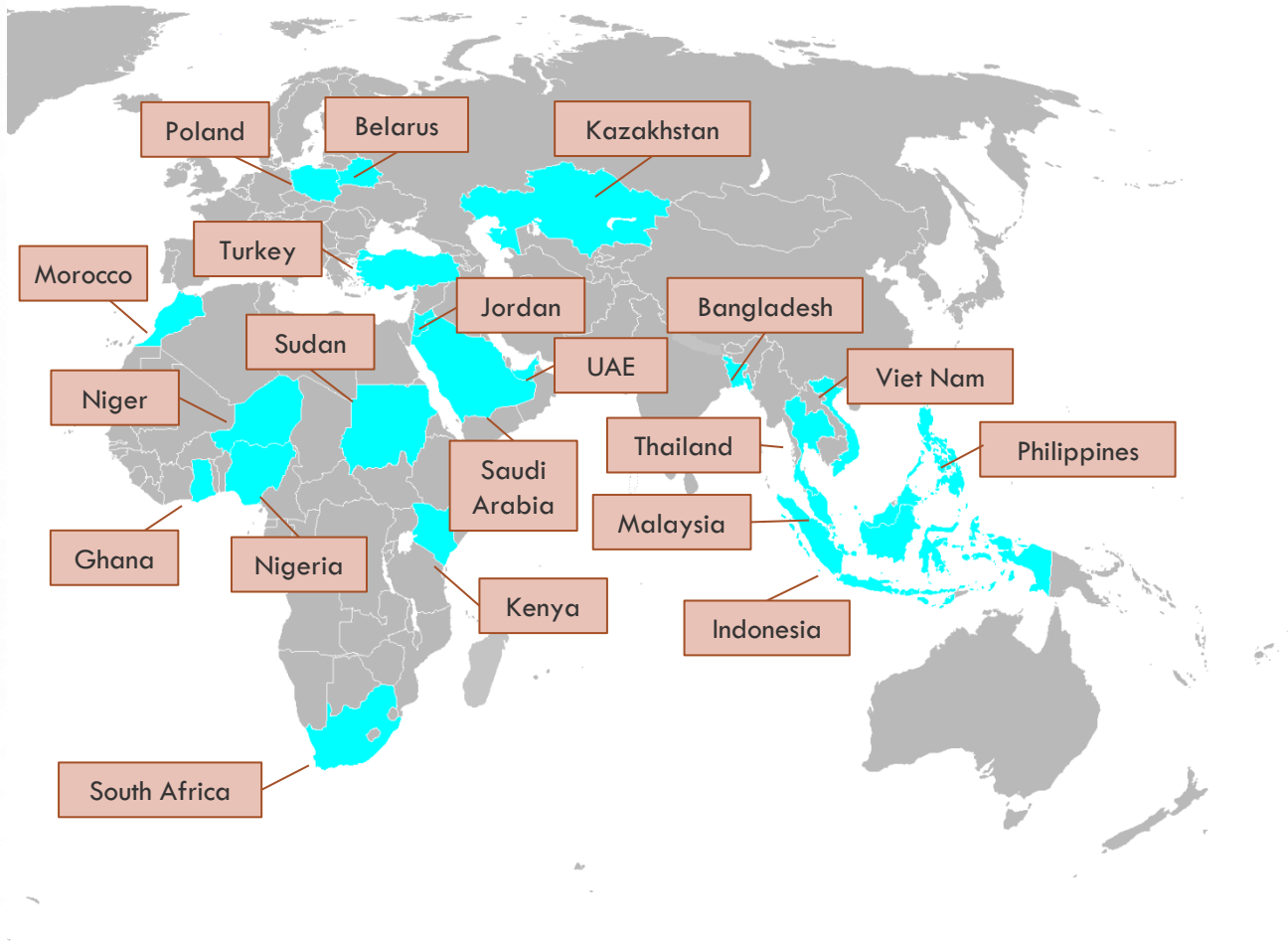
The Milestones Approach is holistic and considers 19 specific infrastructure issues. Issued in 2007; updated in 2015

IAEA Milestones Approach: Infrastructure Development Phases



INIR Missions 2009-2018

1.	**Jordan (Phase 1)**	2009
2.	**Indonesia (Phase 1)**	2009
3.	**Viet Nam (Phase 1)**	2009
4.	**Thailand (Phase 1)**	2010
5.	**UAE (Phase 2)**	2011
6.	**Bangladesh (Phase 1&2)**	2011
7.	**Jordan follow-up**	2012
8.	**Belarus (Phase 1&2)**	2012
9.	**Viet Nam (Phase 2)**	2012
10.	**Poland (Phase 1)**	2013
11.	**South Africa (Phase 2)**	2013
12.	**Turkey (Phase 2)**	2013
13.	**Jordan (Phase 2)**	2014
14.	**Viet Nam follow-up**	2014
15.	**Nigeria (Phase 2)**	2015
16.	**Kenya (Phase 1)**	2015
17.	**Morocco (Phase 1)**	2015
18.	**Bangladesh follow-up**	2016
19.	**Poland follow-up**	2016
20.	**Kazakhstan (Phase 1)**	2016
21.	**Malaysia (Phase 1)**	2016
22.	**Ghana (Phase 1)**	2017
23.	**Niger (Phase 1)**	2018
24.	**UAE (Phase 3)**	2018
25.	**Saudi Arabia (Phase 2)**	2018
26.	**Sudan (Phase 1)**	2018
27.	**Philippines (Phase 1)**	2018



27 INIR missions in 20 Member States