Nuclear energy as part of the energy mix of Algeria to meet sustainability

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Outline

- Status of the African Power Sector
- What about Algeria ?
- Nuclear energy within the energy transition towards decarbonisation
- Small Modular Reactors is this the answer ? Why ?
- Towards a Sustainable nuclear future in Algeria
- Conclusions

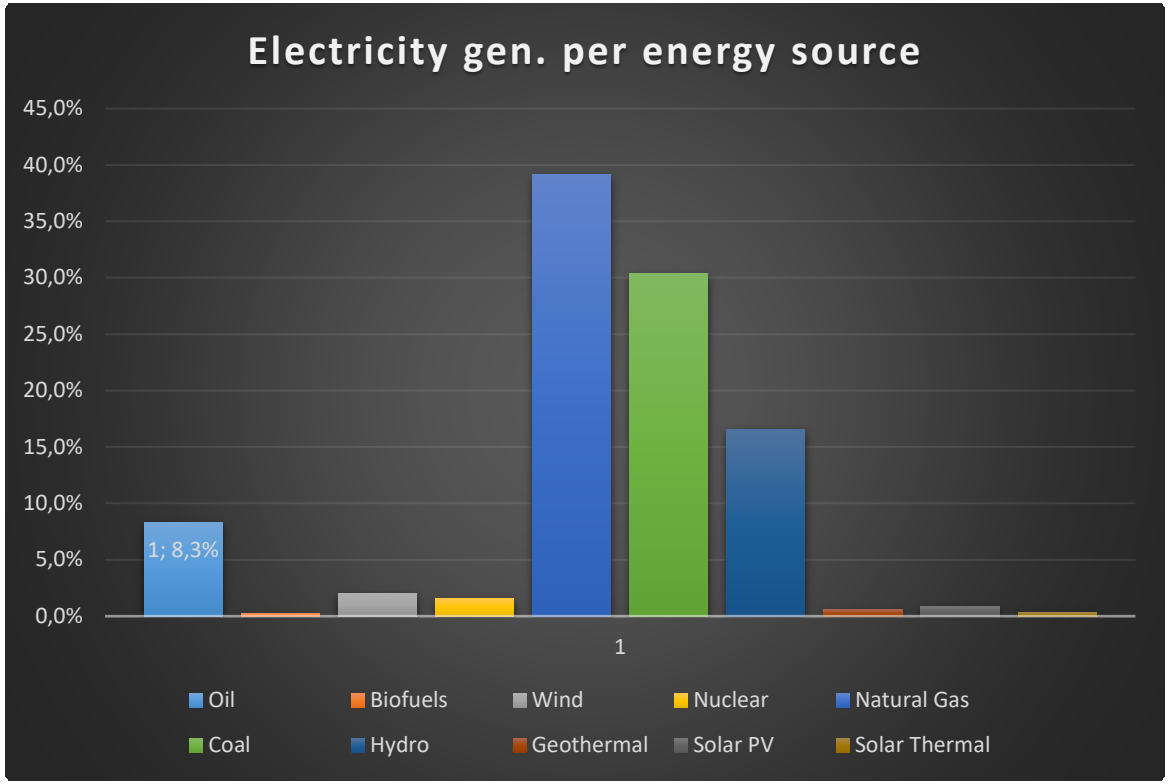
Status of the African Power Sector

- Electricity deficit is a very serious issue in Africa, particularly in sub-saharian countries whereas Africa is very high growing economy and also high growing population.
  - It affects education, health and businesses, being one of the main reasons preventing the economic development of the continent.
  - Causes of this power crisis include:
    - Insufficient investment
    - Lack of diversification
    - Droughts
    - Oil & gas price hikes
    - Conflicts damaging infrastructure
    - Lack of maintenance culture & skills
    - Drain of competencies to other continents

Status of the African electricity generation

Fossil fuel-based electricity generation is the largest source of electricity in Africa (statistics for 2019).

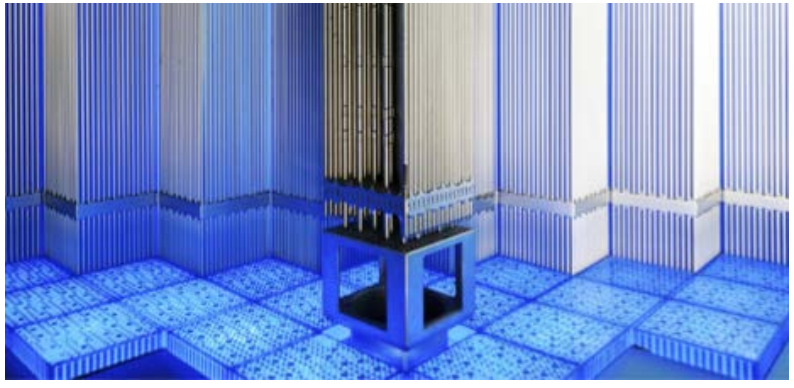
- Coal, oil and gas account for more than 78%
- Hydro 16,5%
- Renewables (Wind, Solar PV+Th, Geotherm.) 3,78%
- Nuclear 1,6%



*https://www.iea.org/regions/Africa

The Nuclear Option for Africa

- Nuclear energy presents the following advantages:
  - Reduced reliance on fossil fuels means less greenhouse emissions.
  - Efficiency: more energy produced per unit of fuel.
  - Reliable baseload capacity.
  - Provides stable and competitive energy prices.
  - Proven technology (for LWR based technology).
  - Large return of experience on plant safety.

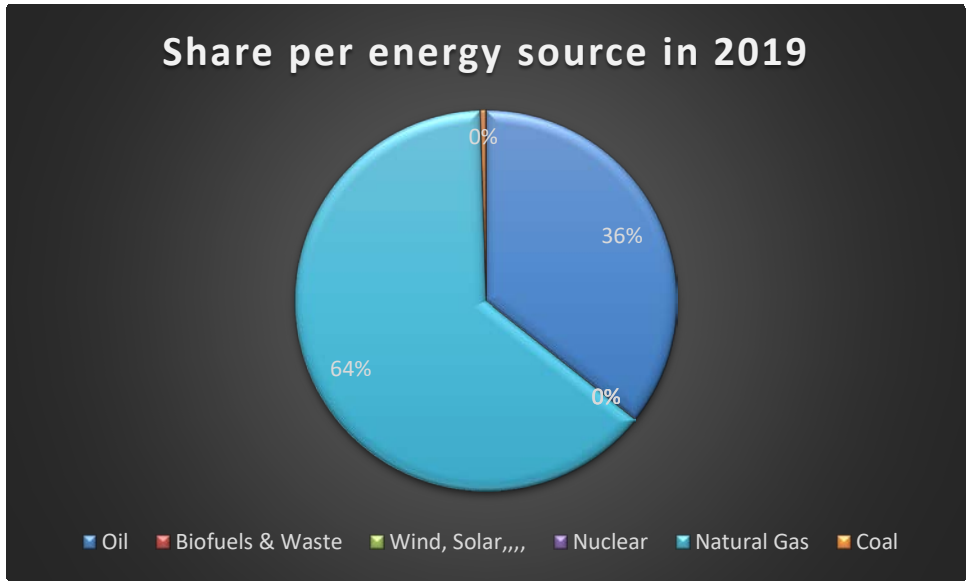


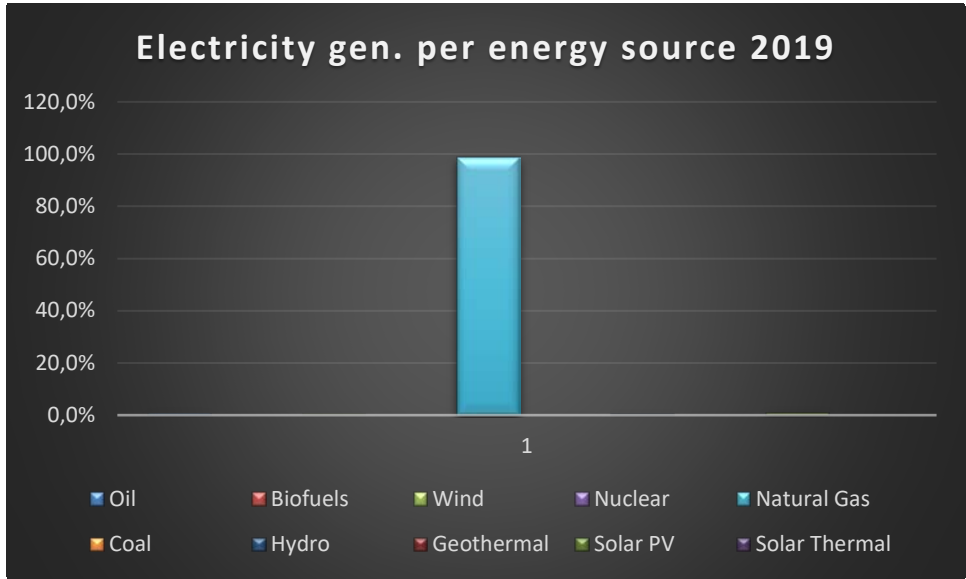
What about Algeria

- Energy in Algeria is dominated by Gas & Oil
- Gas & oil are the basis of Algerian economy
  - Internal consumption increasing dramatically

- Electricity generation is nearly 100% based on Gas (98,6%)
  - Solar PV 0,8%
  - Oil 0,4%
  - Hydro 0,2%

*https://www.iea.org/countriess/Algeria

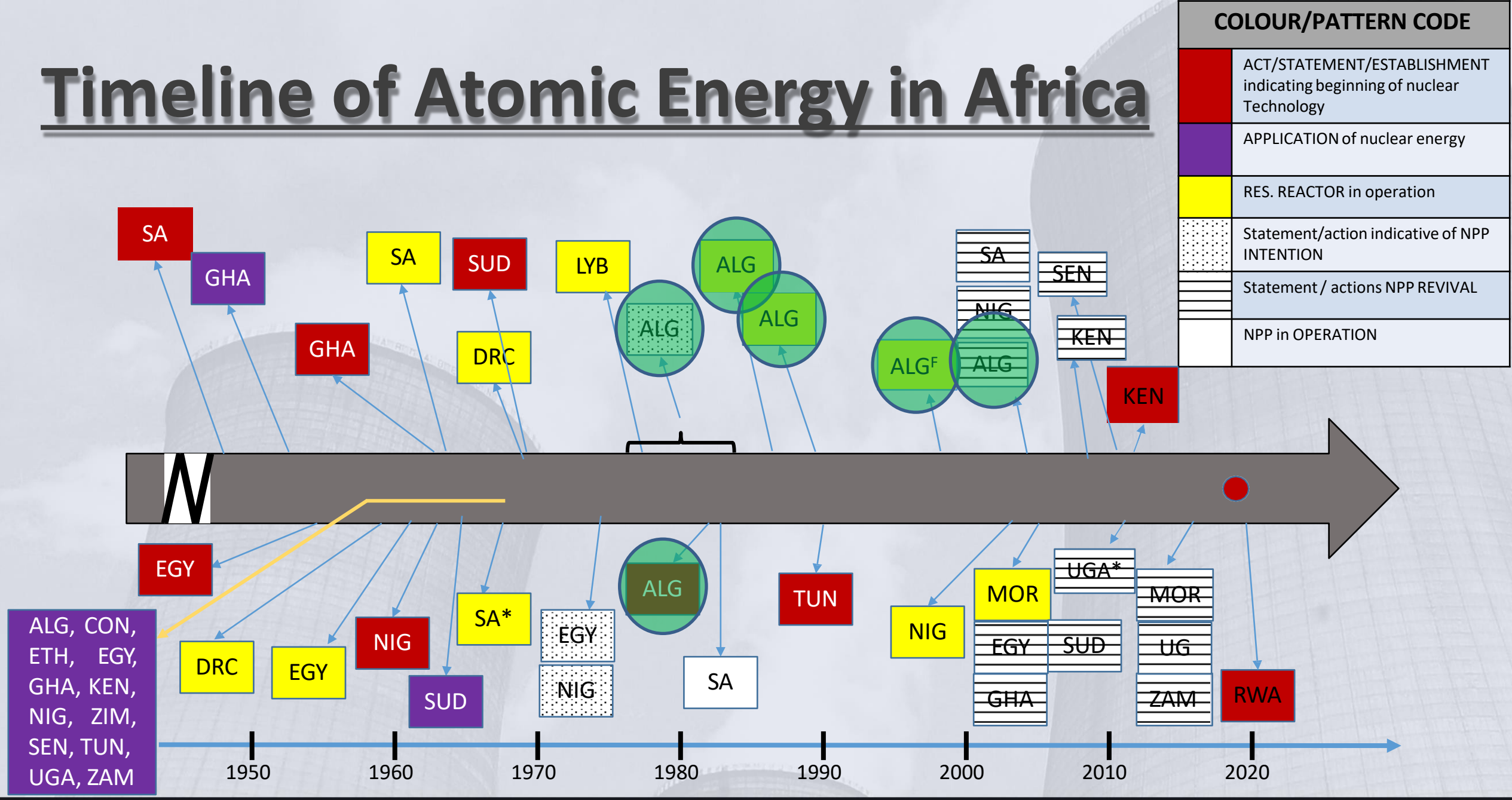




The Nuclear Option for Algeria

- Algeria is pioneering country having considered nuclear power generation in Africa
- Algeria has 4 nuclear research centres with needed technical and technological labs & basics equipment for preparing the needed skills & competences as well as mastering the technology
- Algeria has educated enough people to initiate the preparatory phase for implementing nuclear power in the country
- Algeria has an interesting diaspora of experts in nuclear power generation and technology that can contribute to this endeavour

Timeline of Atomic Energy in Africa



Cortesy AFCONE – Ref : Charles Kofi KLUTSE, Ph. D

Nuclear energy in the energy transition

IPCC Special Report on Global Warming* of 1.5 °C

- Highly confident of nuclear energy's role in most 1.5°C pathways (Finding C2.2.2.)
- By mid-century, the majority of primary energy comes from non-fossil fuels (i.e., renewables **and nuclear energy**) in most 1.5°C pathways. (p 130)
- **Nuclear power increases its share** in most 1.5°C pathways with no or limited overshoot by 2050 (p 131)
- There are large differences in nuclear power between models and across pathways (p 131)
- The **bulk of investments** are projected to be **for clean electricity** generation, **particularly solar and wind power as well as nuclear power**. (…) The precise apportioning of these investments depends on model assumptions and societal preferences related to mitigation strategies and policy choices (p 154)

In 2018, in the media and particularly in the Belgian ones, no one mentions the important role of NE and that without NE we will not make it !

In COP26 Nuclear was back thinkable

*https://www.ipcc.ch/sr15/chapter/spm/

Nuclear energy in the energy transition towards decarbonisation

- Decarbonisation ➔ less primary carbon-based energy sources use & more electricity consumption
- Todays tendency: Renewables will do the job (not realistic)
- Nuclear energy contributes to the following features
  - Major contribution to **security** of energy supply
  - A **dispatchable production** for a stable and competitive electricity generation
  - Providing **non-electricity energy services** for water desalination, hydrogen production, district heating and process heat
  - Stable prices on the long-term (uranium ore represents **today 6 to 8% of the KWh price, Gas 70%**)
  - Providing long-term human resources employment (**economic and well-fare pay back**)
  - Developing **high level technology industries** (important to activate the **local industry in the supply chain**)

The Nuclear Option for Algeria

- Challenges faced by Large Reactors searching for Capital Investment:
  - **Large up-front investment escalation** (France, Finland). Flamanville and Olkiluoto are three times over budget.
  - EPR investment plans in UK illustrate funding size challenge. **Chinese investment needed for financing**: which country can still finance LRs?
  - Financial distress :
    - Areva in financial distress caused (primarily) by Flamanville and Olkiluoto cost overruns, French Government stepped in to save the company.
    - Westinghouse filed for Chapter 11 protection on March 29th 2017, caused (primarily) by cost overrun of 4 AP-1000 reactors in the USA

Increased uncertainty around Large Reactors in terms of Economic requirements (affordability + predictability)

Large reactors vs Small Modilar Reactor

Large Reactor

3000 MWth ➔1000 MWe (η: 33%)

7% → **Decay Heat: 210 MWth**

Active safety system
Restricted location (need of water)

Based on Economy of Scale
- Capital intensive (PWR: 4-6 bn $)
- Long construction time (>10 years)

Small Modular Reactor

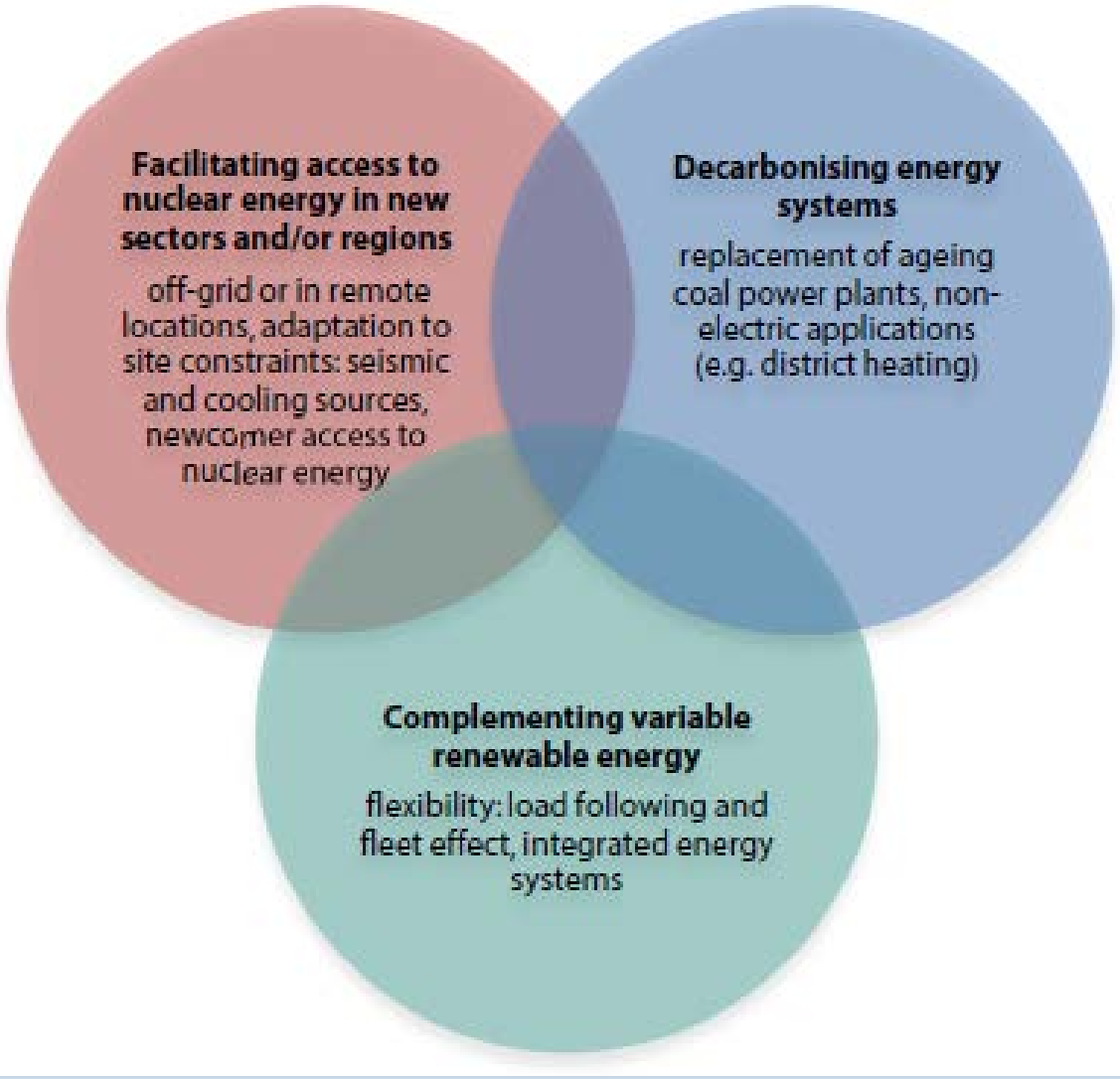
< 900 MWth ➔< 300 MWe (η≥ 33%)

7% → **Decay heat: < 63 MWth**

Passive safety system
Larger deploy. Arid, arctic region, …

Based on Economy of Series
- Standardized components
- Less capital intensive (1-2 bn $)
- Short construction time (<5 years)

SMR objectives

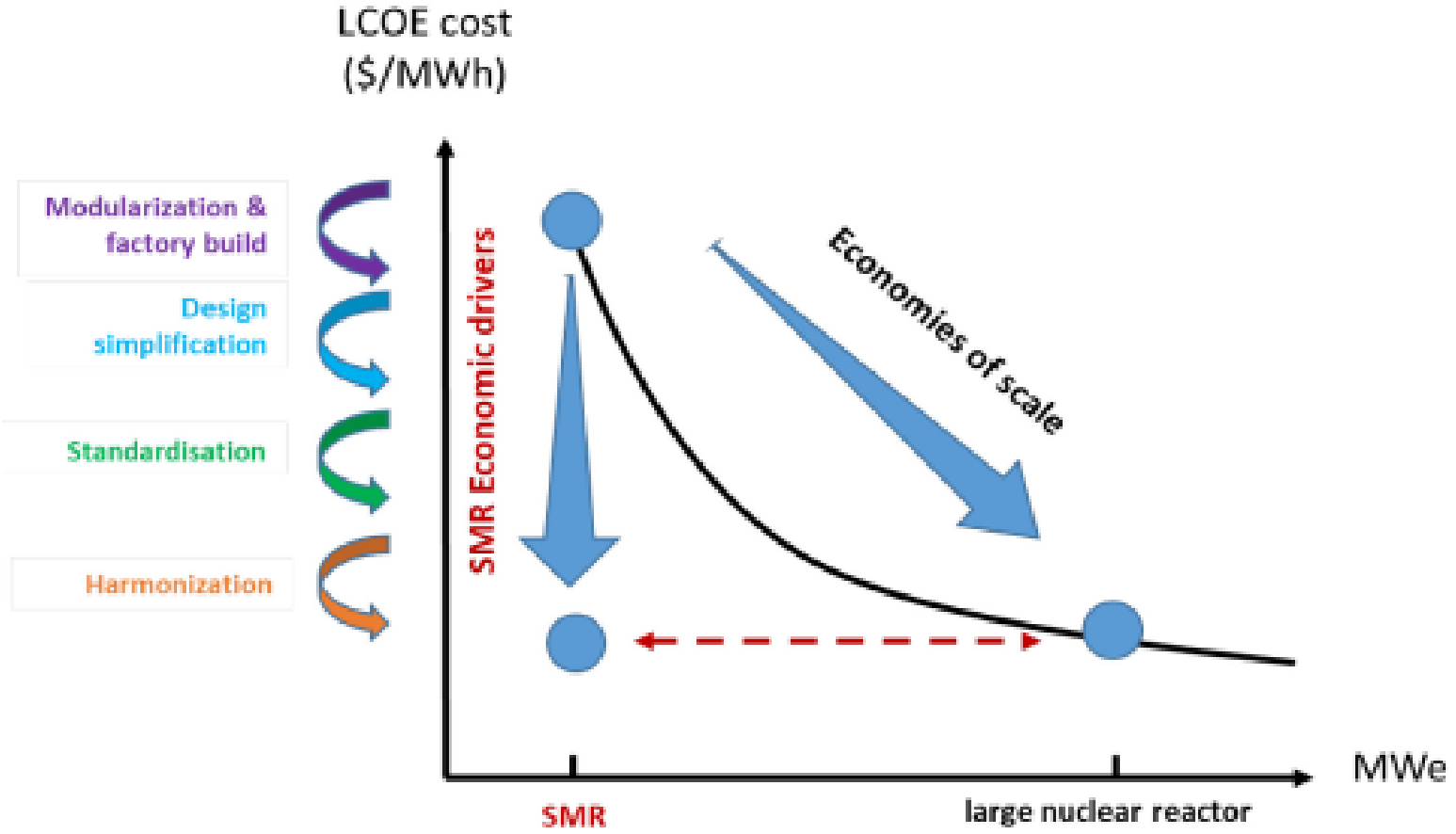


Small Modular & Medium Reactor (SMR)

- SMR: Small **Medium** (sized) Reactor or Small **Modular** Reactors
  - **Small** Reactor: up to 300 MWe
  - **Modular** reactor: grouping of individual reactors to form a large nuclear plant or use of factory **pre-fabricated modules** assembled on-site, “plug-and-play”
  - **µ-SMR** is an extra concept of reactor with power ranging between 1 to 10 MWe, considered for serving off-grid in remote locations
  - LR: **Large** Reactor: > 700 MWe
- Two kinds of SMR : “thermal” and “fast” (neutronic spectrum)

Source: World Nuclear Association (WNA) Small nuclear power reactors – Updated June 2016”

SMR economics



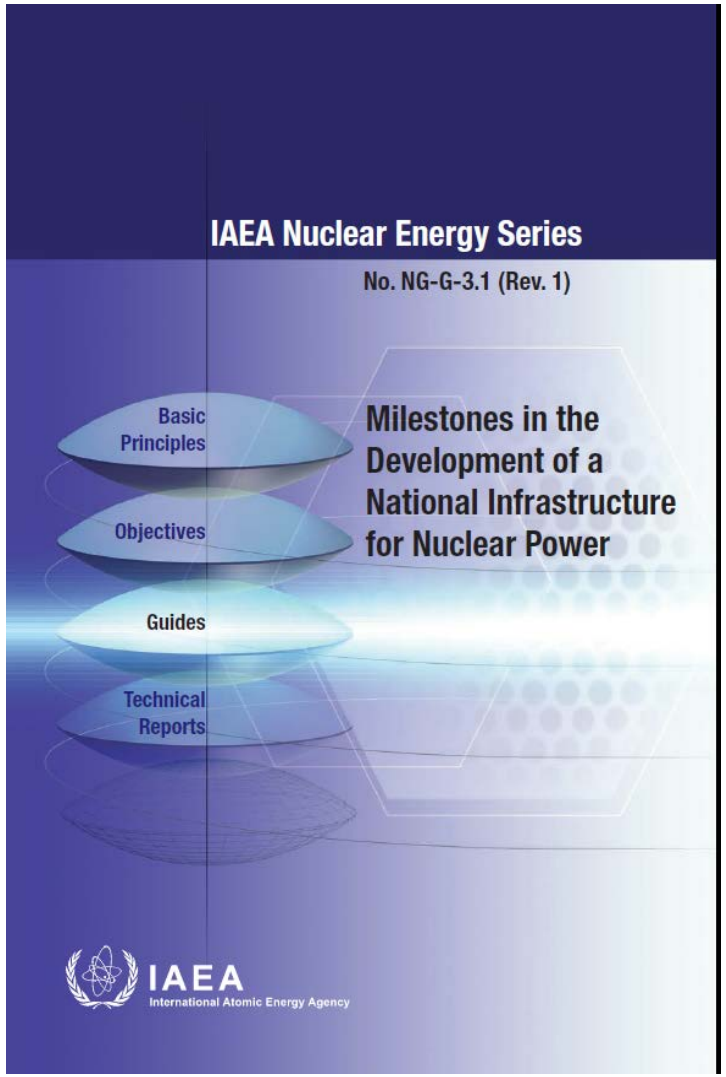
Source: NEA (2020).

Note: KW_e = kilowatt electric.

SMR concepts: status & characteristics

- SMRs are not new – present since beginning of the nuclear era
- Initial design in submarines (USS Nautilus 1955), ice-breakers, **BR3 (1st PWR in BE; 11 Mwe started in 1962)**
- Today more than 50 designs and concepts are under development in various countries
- The level of development is ranging from conceptual stage to constructed as indicated in next tables :
  - Dark green: SMR in operation, commissioned or finishing construction
  - Light green: under construction
  - Orange: licensed or certified by regulator
  - Red: submitted for permit
  - No color: conceptual design

Towards a sustainable nuclear future in Algeria



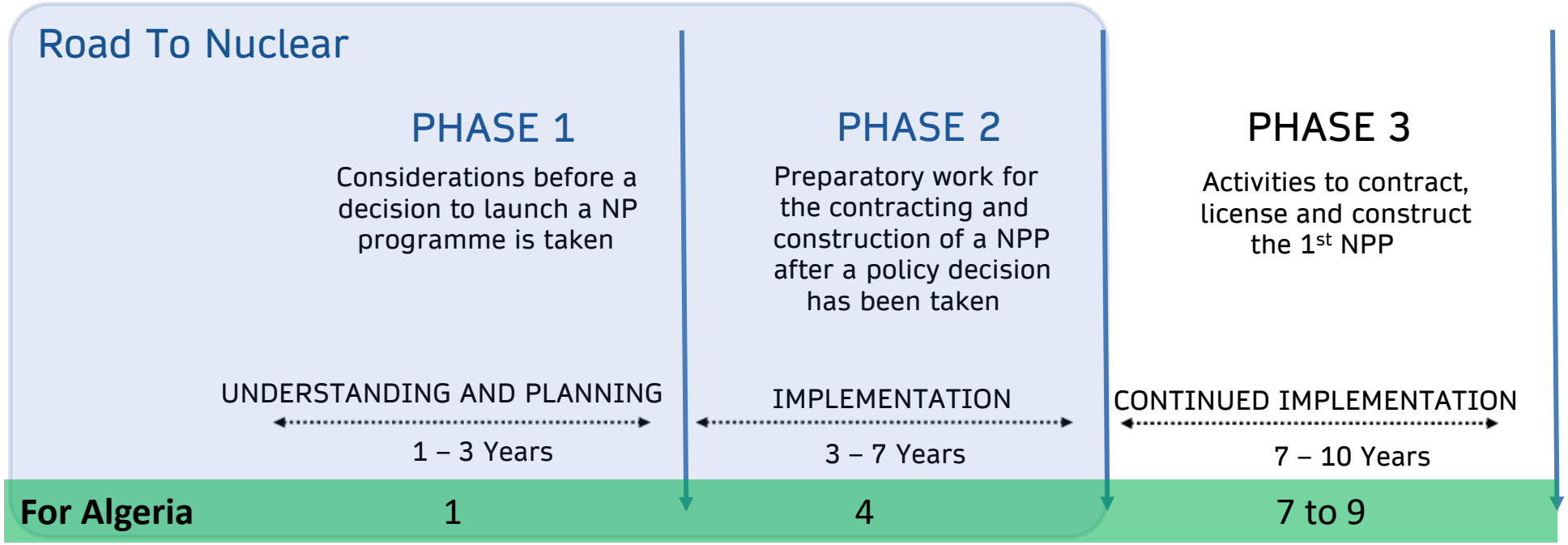
- Well established methodology by IAEA
- Well known to Algerian actors who contributed in this effort:
  - Ministry of Energy
  - COMENA
  - SONELGAZ
  - SONATRACH
- 19 Milestones: all important but some are crucial in my view :
  - 1 **National position : long and continuous commitment**
  - 2 Nuclear safety
  - 4 **Funding and financing**
  - 6 Safeguards
  - 10 Human resource development
  - 11 Stakeholder involvement
  - 16 **Nuclear fuel cycle**
  - 17 Radioactive waste Mgt
  - 19 Procurement

Phased implementation well defined with 2 Milestones in time (INIR*)

MILESTONE 1
Ready to make knowledgeable commitment

MILESTONE 2
Ready to invite bids/negotiate contracts for the first of a NPP fleet

MILESTONE 3
Ready to commission and operate the first of a NPP fleet



* **Integrated Nuclear Infrastructure Review by IAEA**

Conclusion

- Nuclear Energy deployment is feasible within a period of 10 to 15 years
- The development of SMR technology worldwide is an added value for easing this deployment and compatible with the Algerian calendar
- Competences within the country and abroad are available
- The Climate change & the country energy security constraints are urging
- Major actors are present in the country such as utility and energy major company ready for heavy and complex contracts mgt and Nuclear technology specialist such as COMENA
- **This can make it a winning constellation with a nation strong and continuous commitment for Nuclear Power introduction in the energy mix**