

The Moroccan NPP Project and SMR perspectives

SMR Technical Working Group

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- **SUMMARY:**

- ❖ **Moroccan Energy System Evolution**

- ❖ **The Moroccan NPP Project**

- ❖ **The Regulatory & Legislative framework**

- ❖ **The Maamora Nuclear Research Center**

- ❖ **The incentives of SMR's**

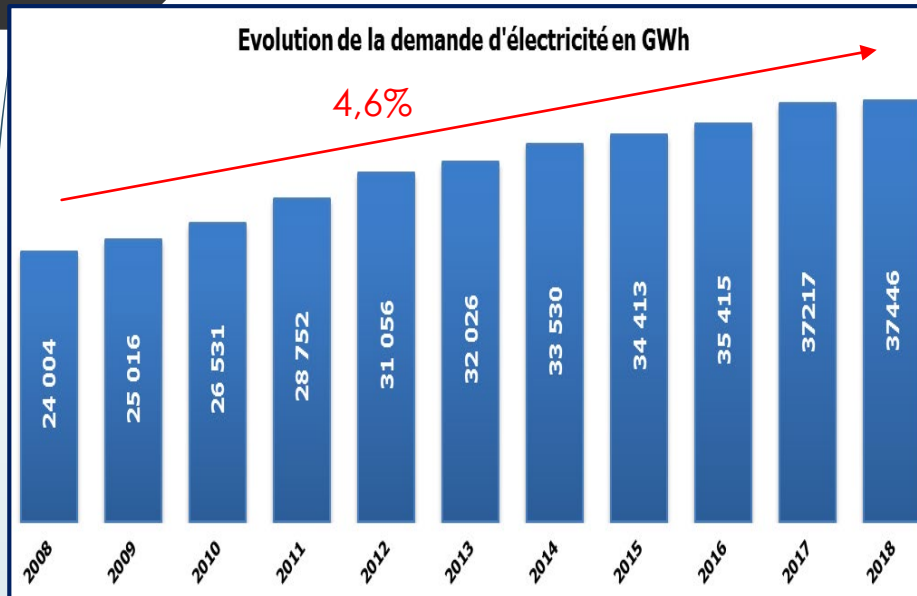
- ❖ **Conclusion**

***Morocco joined the IAEA SMR-TWG
2 months ago***

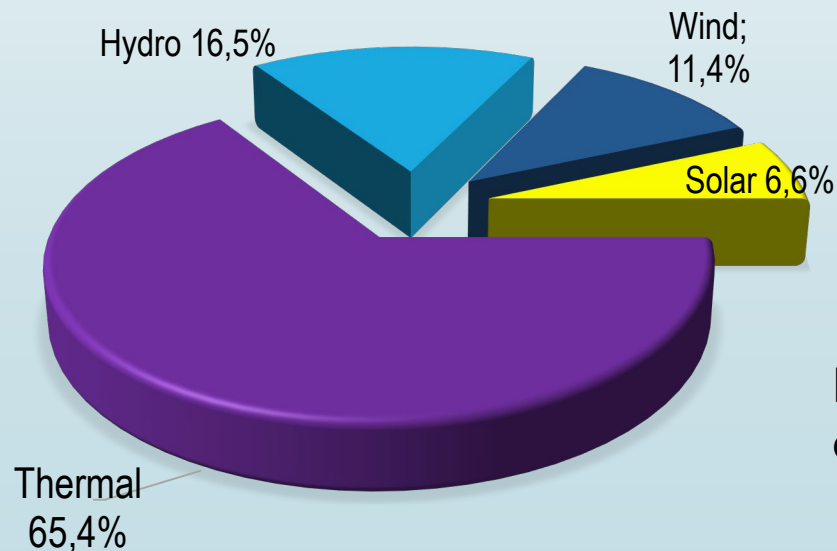
MOROCCO: A GROWING ELECTRICITY DEMAND

Average Growth
Rate: 4,6%

General Data (2019)

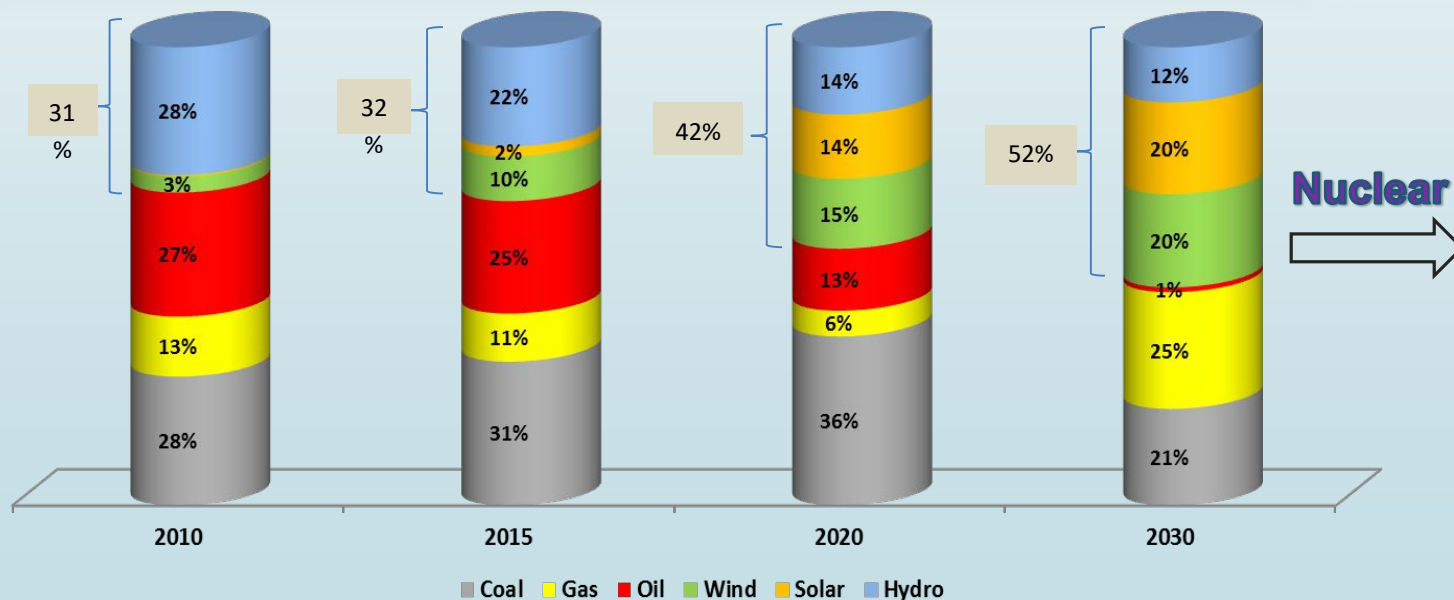
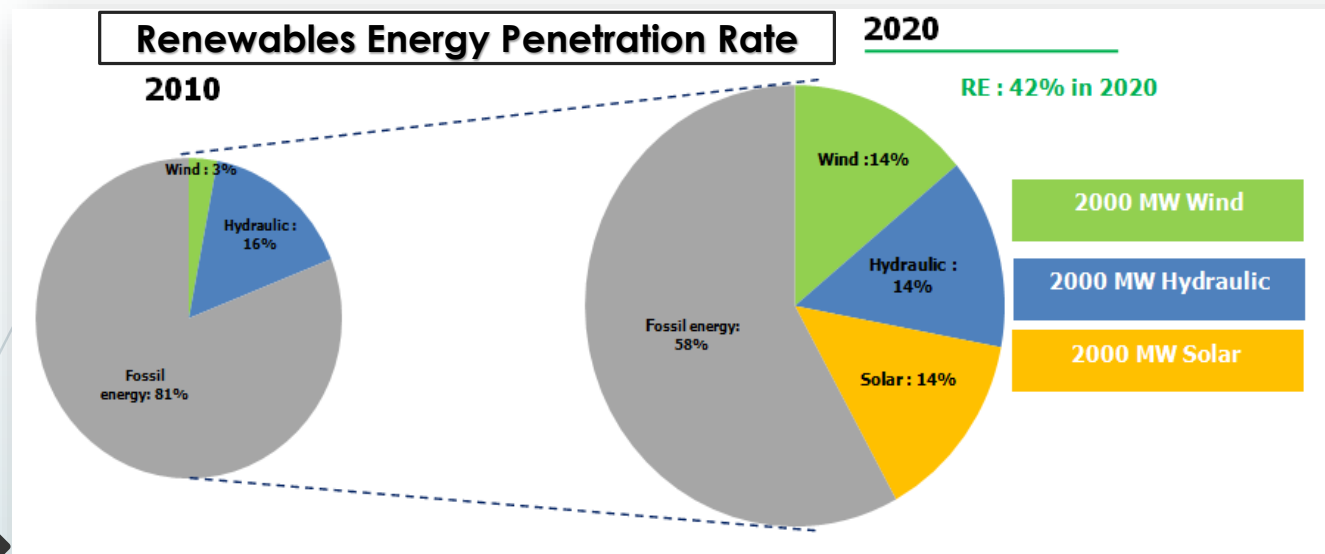


- ❑ Total Installed Capacity : **10 677 MWe**
- ❑ Demand growth rate (2018/2019): **+3,8%**
- ❑ Energy production : **40 348 GWh**
- ❑ Rural Electrification Rate: **99,68%**
- ❑ Installed Interconnection Capacities:
 - ❑ 1400 MW With Spain
 - ❑ 2400 MW with Algeria



**Installed capacity by
energy source (2019)**

The Moroccan Energy Mix Evolution



THE MOROCCAN NUCLEAR POWER PROJECT

1- The First Feasibility and Sites Study (1984-1995)

- ❑ The first Feasibility Study (FS) to introduce a first NPP in Morocco was undertaken by **Morocco and French** under bilateral cooperation. The FS was realized by the National Utility **ONEE** with the services of the French Consultant **SOFRATOME** and with **IAEA** assistance;
- ❑ A very exhaustive sites studies lead to the choice of the **Sidi Boulbra site**, located at Atlantic Sea between SAFI and Essaouira cities (300 km in the south of Casablanca), as the appropriate site with no **characteristics that would prevent the construction of an NPP units under the safety requirements. This conclusion was validated by IAEA mission Experts.**
- ❑ A detailed studies in many NPP areas (technical, economical, regulatory, organizational, ..) have been done and thousands reports have been written, including a detailed **Technical Specifications** of the NPP and the Preliminary **Site safety Report**.

2- The Feasibility of Nuclear desalination with China (1997-2000)

- ❑ A bilateral convention between Morocco and China was signed and a technico-economic feasibility has been realized based on small nuclear reactor for **seawater desalination** production in the south of Morocco (Tantan City),
- ❑ The technology proposed was the Chinese **NHR (Nuclear Heating Reactor)** with two power ranges : 10MWth and 200 MWth.

THE MOROCCAN NUCLEAR POWER PROJECT

3- Updating the Feasibility and Sites Study

- ❑ The ONEE update this FS on a regular basis (technology, economic competitiveness,..etc)
- ❑ The technology assessment lead to the choice of **Proven & commercially available** Nuclear Reactor technology, mainly **PWR GIII technology** ;
- ❑ The updated **Sidi Boulbra site** characteristics still presents several positive aspects related to safety and external environmental risks
- ❑ After a non bidding process undertaken in 2007 with the potential technology vendors (AREVA, KHNP, AECL, ATOMSTROYEXPORT), ONEE has elaborated the Bid Invitation documents (**EPC** contract, **O&M** contract, **Fuel** supply contract, **PPA** contract,..) in the perspective of carrying out the NPP based on **Independent Power Purchase** contract scheme.

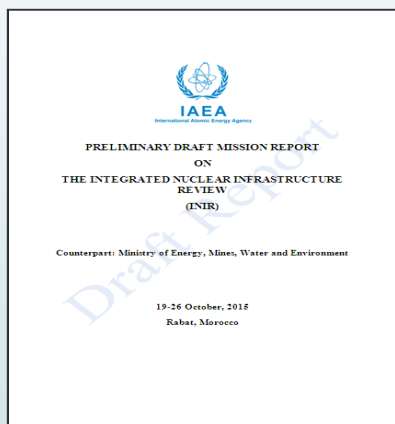
THE MOROCCAN NUCLEAR POWER PROJECT

4- IAEA Milestones Approach and INIR Mission

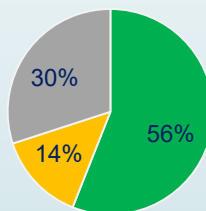
- ❑ In response to the recommendation of the IAEA Milestones approach (**19 infrastructure's issues**), the Ministry of Energy and Mines of Morocco has set up, in 2009, a national committee called **(CRED)**, equivalent to the IAEA's **Pre-NEPIO** (Preliminary Nuclear Energy Implementing Organization).
- ❑ The CRED has representatives from various Moroccan organizations and institutions (**Ministry of Energy, National Electricity and Water Utility, Nuclear Research Center, Regulatory Body, Ministry of Health, Nuclear engineers association, University,..**)
- ❑ Since its setting up, the CRED has organized itself into several working groups (WGs) and has produced two national Self Evaluation Reports (SERs). The latter report (2014) has served as the basis for the conduct of **the IAEA's INIR mission (Rabat 19-26 October 2015)**.



- The INIR mission report found that Morocco has developed base of knowledge and experience in nuclear activities in its preparation to **make knowledgeable decision** about introducing nuclear energy in its electrical system (**phase 1** : take a knowledgeable decision).
- A **Integrated Work Plan** has been drawn over the period **2016-2020** and the work is being finalized by the CRED's WG's to implement the IAEA recommendations related to the **19** Infrastructures issues and to prepare a **Comprehensive Report** summarizing the key elements for supporting the National Decision.



- Phase 1 conditions satisfied
- Phase 1 conditions partially satisfied
- Phase 1 conditions yet to be satisfied



**The Comprehensive Report (Phase 1)
should be finalized before the end of 2020
for Supporting National Decision**



Phase 2 ?

THE REGULATORY AND LEGISLATIVE FRAMEWORK

1- The Regulatory framework

- ❑ A new National **Nuclear Law (Loi 142-12)** on nuclear safety and nuclear security has been promulgated in 2014.
- ❑ In the framework of this law, an independent Nuclear Safety Authority, called “**Agence Marocaine de Sûreté, Sécurité Nucléaire et Radiologique**” (**AMSSNuR**) has been established in 2016, with authority and financial support from government.
- ❑ At present, AMSSNuR is elaborating the required package of regulatory texts (Decrees, Guides,..) in the nuclear activities **including NPP installations** and with the collaboration of the national organizations concerned. The finalized texts has been submitted to the Government for approval, some others are being finalized.

2- Main International Conventions and Treaties ratified by Morocco.

Morocco has ratified almost the main International Conventions and Treaties related to nuclear energy field:

- ✓ NPT and IAEA Safeguards,
- ✓ Additional Protocol,
- ✓ Physical protection convention and its amendment,
- ✓ Nuclear Civil liability Convention ; convention in reparation on nuclear supplementary damages,
- ✓ Nuclear safety Convention,
- ✓ Joint convention on spent fuel and radioactive waste management,

The National Center For Nuclear Energy, Science And Technology (CNESTEN) and the The MAAMORA Nuclear Research Center (Maamora NRC)

CNESTEN

Established in 1986 with the following missions :

- Managing the Nuclear Research Center of Maamora (based on **Triga Mark 2 research reactor** and its associated laboratories),
- Developing scientific research in nuclear science and technology,
- Promoting nuclear applications in socio-economic sectors (Agriculture, Water, Industrial applications,...)
- Contributing to the development of infrastructure for a nuclear power program
- Acting as a Technical Support Organization (TSO) for national authorities,
- Managing radioactive waste at national level.

The Maamora NRC: more than 20 years of operating experience



Expertise in different activities :

- ☐ Nuclear Medicine and life sciences (Production of radioisotopes)
- ☐ Industrial Applications Natural Resources & Environment applications
- ☐ Safety & Security
- ☐ Radioactive Waste Management
- ☐ Research & Development
- ☐ Training

1999-2002: Construction of laboratories and associated facilities

2004-2006 : Construction of the **TRIGA Mark II 2MW** Research Reactor

- ☐ Regional Training Center in the fields of radiation protection, Isotope hydrology, Industry and Nutrition (IAEA-AFRA)
- ☐ National Center for NDT training and certification
- ☐ National Support Training Center in Nuclear Security field with International assistance (IAEA, US DOE)
- ☐ National Support Training for Emergency Preparedness and Nuclear Security (Emergency Response exercises, Nuclear Security exercises, ..)
- ☐ Availability of a Research Reactor as powerful tool for training (Universities)
- ☐ A new Training Center in Nuclear Science and Technology is under construction in the Maamora NRC

Incentives for SMR

The incentives for thinking about SMR's in Morocco could be summarized in the main following aspects:

- ✓ The nuclear option is planned in the national energy mix beyond 2030
- ✓ The **Lower** capital and investment **cost** of SMR's due to lower power output range and short construction period (modular construction) ;
- ✓ the project **risks** are lower and their **financing** should be more **easier** ;
- ✓ The introduction of NPP option in the electric grid network (with medium capacitatives), will be more flexible;
- ✓ Morocco is a country with **high penetration rate of Renewables Energy** and SMR's could be a part of solution required to adjust the electrical grid to offset cyclical wind and solar generation (replacement of pollutant coal and gaz power plants by SMR with load following capabilities) ;
- ✓ Using SMR in cogeneration of electricity and **seawater desalination** (to match the growing water demand) and eventually other industrial uses ;
- ✓ The **technology transfer and the national involvement** (industrial participation/localisation and human ressources development) will be more effective and could be a springboard for more national involvement in complexe NPP projects (NPP program);
- ✓ The SMR **inherent safety features** is a strong incentive for public acceptance and stakeholders involvement to implement the nuclear option.

➡ But the the SMR technology should be a proven and commercialy available with Reference Plants and suffisant feedback.

CONCLUSION

- Morocco joined recently the IAEA SMR-TWG as **Observer Member**,
- The assessment of the necessary National **NPP Infrastructures**, according the IAEA milestones approach (Phase 1) are being finalized,
- The nuclear Option (both large NPP or SMR's) could be inserted in the national electrical grid beyond 2030 based on a PWR **GIII proven technology** with sufficient operational and safety feedback (Reference Plants required),
- The incentives for **SMR are realistic** due to many positive aspects and Morocco will constitute a **national working group** in order to participate to the activities of SMR's development with IAEA in different aspects (technology assessment, economic of SMR, regulatory aspect, ..),
- Open **on collaboration** with IAEA and other relevant SMR's stockholders.