

# THE CAREM AND A LARGE NPP: A Comparison And Comments From The Argentinean Licensing Experience

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**NUCLEOELECTRICA ARGENTINA S.A.**

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# OUTLINE

- **General Introduction**
- **Recent Licensing Experiences in Argentina**
- **Basis for the Licensing Approach in Argentina**
- **Licensing of the Next Large Nuclear Power Plant (Hualong One)**
- **Licensing of the CAREM Project**
- **Some Considerations for SMRs**
- **Conclusions and Comments**

# OUR COMPANY



NUCLEOELECTRICA ARGENTINA S.A.

In 1994, Nucleoeléctrica Argentina S.A. (NASA) originates from the National Commission of Atomic Energy, as a company created to develop the activity of nuclear power generation.

Nucleoeléctrica Argentina generates electric power, operates the nuclear power plants and manages large nuclear power related projects in the country.

It's a stated-owned nuclear company and a fundamental player in the Argentine electricity market.

## Units under operation

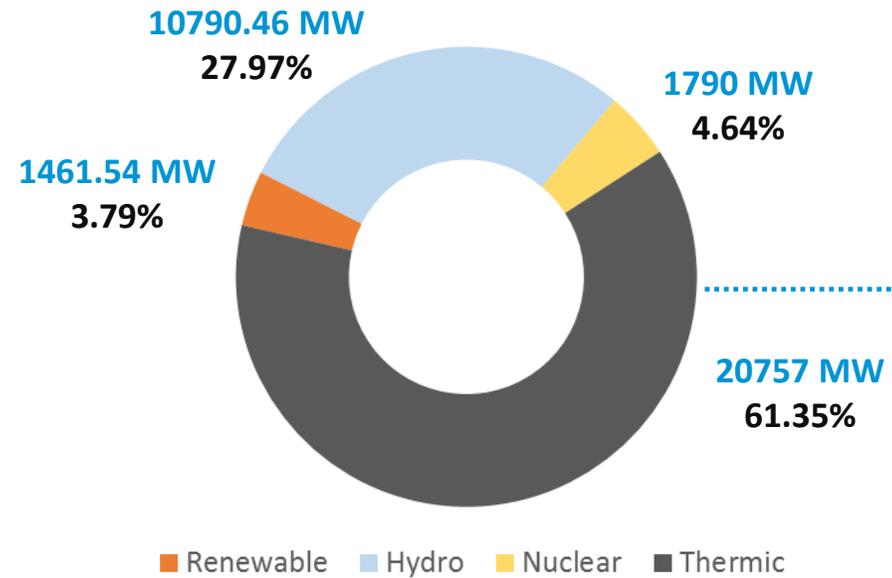
**Atucha I // Atucha II // Embalse**

## Installed power

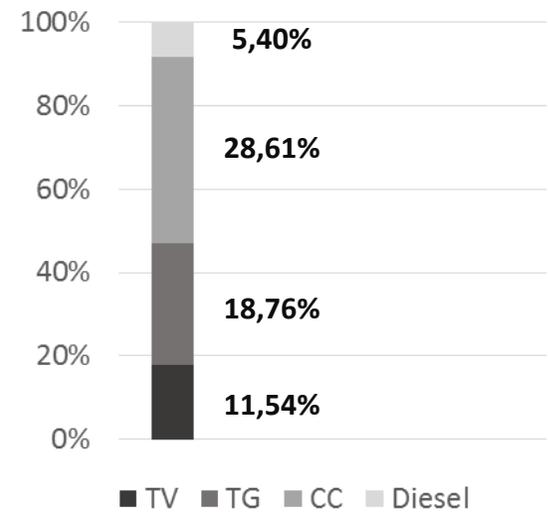
**1,750 MW.**



**ARGENTINE INSTALLED CAPACITY**



**TOTAL CAPACITY: 34.799 MW**



**THERMAL GENERATION**

## RECENT LICENSING EXPERIENCES IN ARGENTINA

- **Construction of the CAREM 25, Prototype for an integrated – advanced SMR**
- **LTO, refurbishment and upgrade of an original CANDU 6 – Embalse Nuclear Power Plant**
- **Preparing the LTO for Atucha I (oldest Nuclear Power Plant)**
- **Control of Atucha II operation**
- **Construction of a Research Reactor (RA-10)**
- **Planning for the Licensing of the next Large Nuclear Power Plant**



## LIFE EXTENSION OF EMBALSE NPP

### RECENTLY ACCOMPLISHED

**Embalse Nuclear Power Plant recently finished its refurbishment program, after shutdown on December 31st, 2015.**

The plant successfully reached criticality on January 4th, 2019.

Total cost of the project 2,149 millions of USD.

Work force involved 3,211 workers (90% of them from the province of Cordoba).

**Every component of the nuclear island replaced was fully manufactured in the country.**

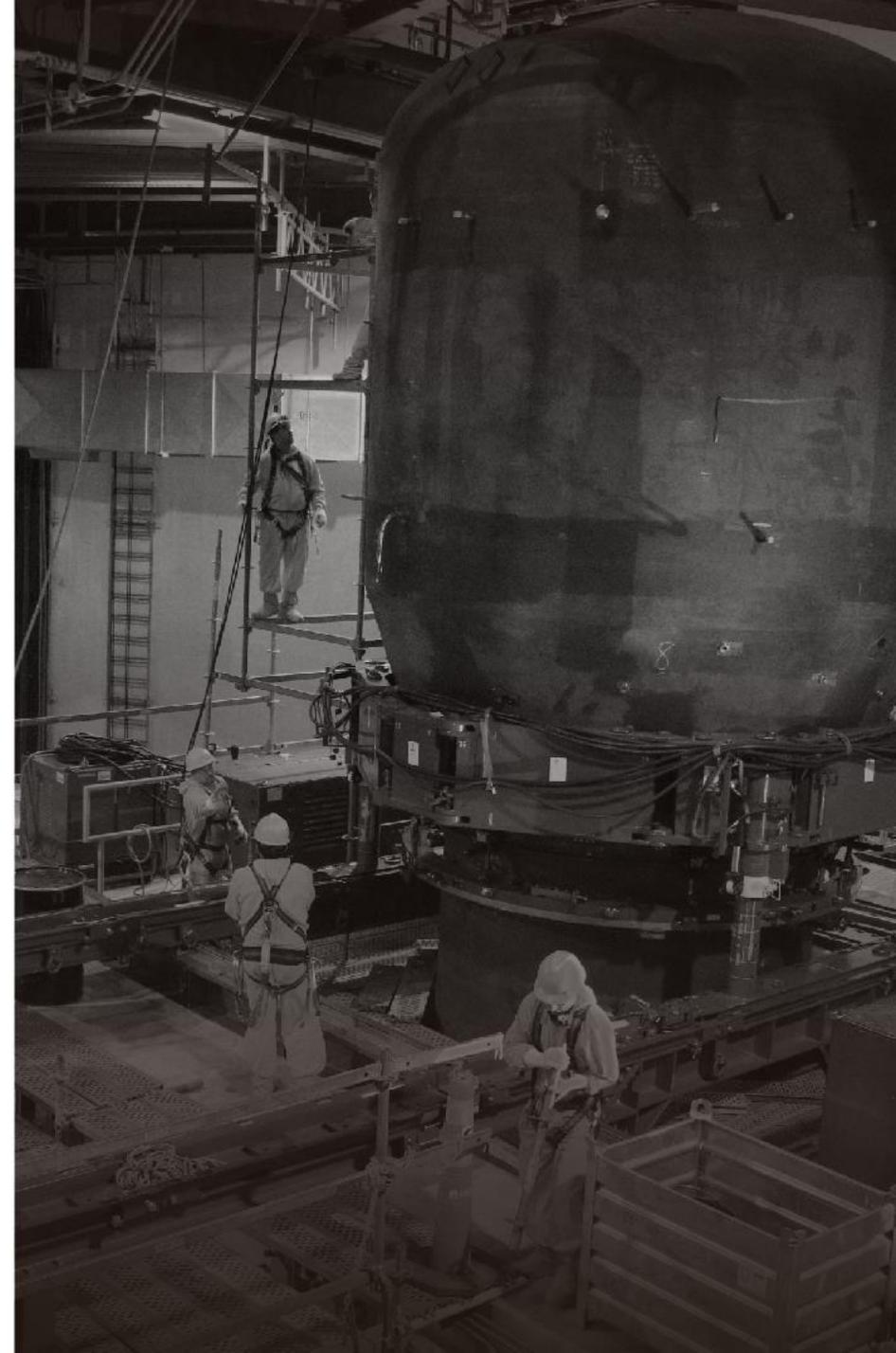
#### **Major Milestones of the Project:**

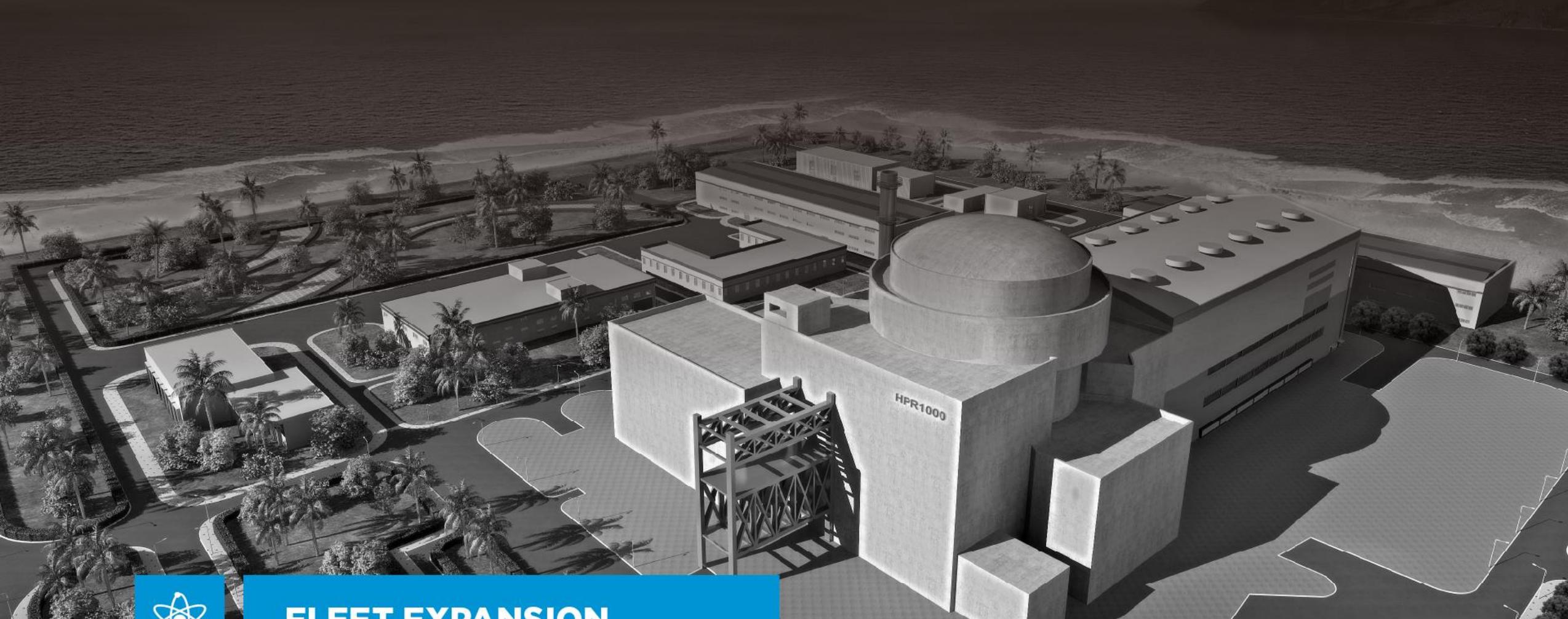
Replacement of 380 fuel channels.

Replacement of 760 feeders

Replacement of all 4 steam generators

Power Uprate the plant on 35 MW, increasing the gross electrical output to 683 MW





## FLEET EXPANSION

**ATUCHA III NPP- 1,150+ MWe (HUALONG ONE)**

PWR type

Civil work and construction to be provided locally plus some localization of components

**Located at the Atucha complex, Buenos Aires**



## THE FUTURE

### **CAREM REACTOR - 32 MWe**

SMR type – Integral PHTS PWR type of reactor

Self Pressurized – Natural Convection Cooled – Passive Safety Systems

100% Argentinean design

**Located at the Atucha complex, Buenos Aires**

## LICENSING APPROACH IN ARGENTINA

### ● Safety Goal (Performance) Oriented approach:

**A top-down process from Safety Objectives – safety functions / safety analysis (DSA – PSA) – classification of SSCs – derivation of engineering requirements for SSCs (design / fabrication / assembling / testing / commissioning / operation / maintenance / etc.)**

- Based on Argentinean regulations (or standards) plus IAEA safety standards plus other as required and convenient
- Tools to “qualify” the compliance with safety requirements on engineering (process, mechanical, I&C, Electrical,...):
  - Experimental / testing
  - Industrial C&S
- Codes and Standards of different origins and cultures have been assimilated due to the dissimilar origin of our large NPP technology providers
- Model well demonstrated in the most successful product of export: High Performance Research Reactors and associated facilities, ‘big science’ local projects, fuel cycle facilities and installations
- The Argentinean Regulator is concerned with safety, radiation protection, safeguards, emergency preparedness and response and, security
- Unlikely to tell the ‘Licensee’ the HOW to do things or to outline ‘implicit’ design solutions, other than with exceptional guidelines or conditions in a license, or a review process

# LICENSING OF THE NEXT LARGE NPP

- Safety Goal based with a well established process:

  - License for Construction

  - License for Commissioning and Fuel Load

  - License for Operation

  - License for Termination of Operation and Decommissioning

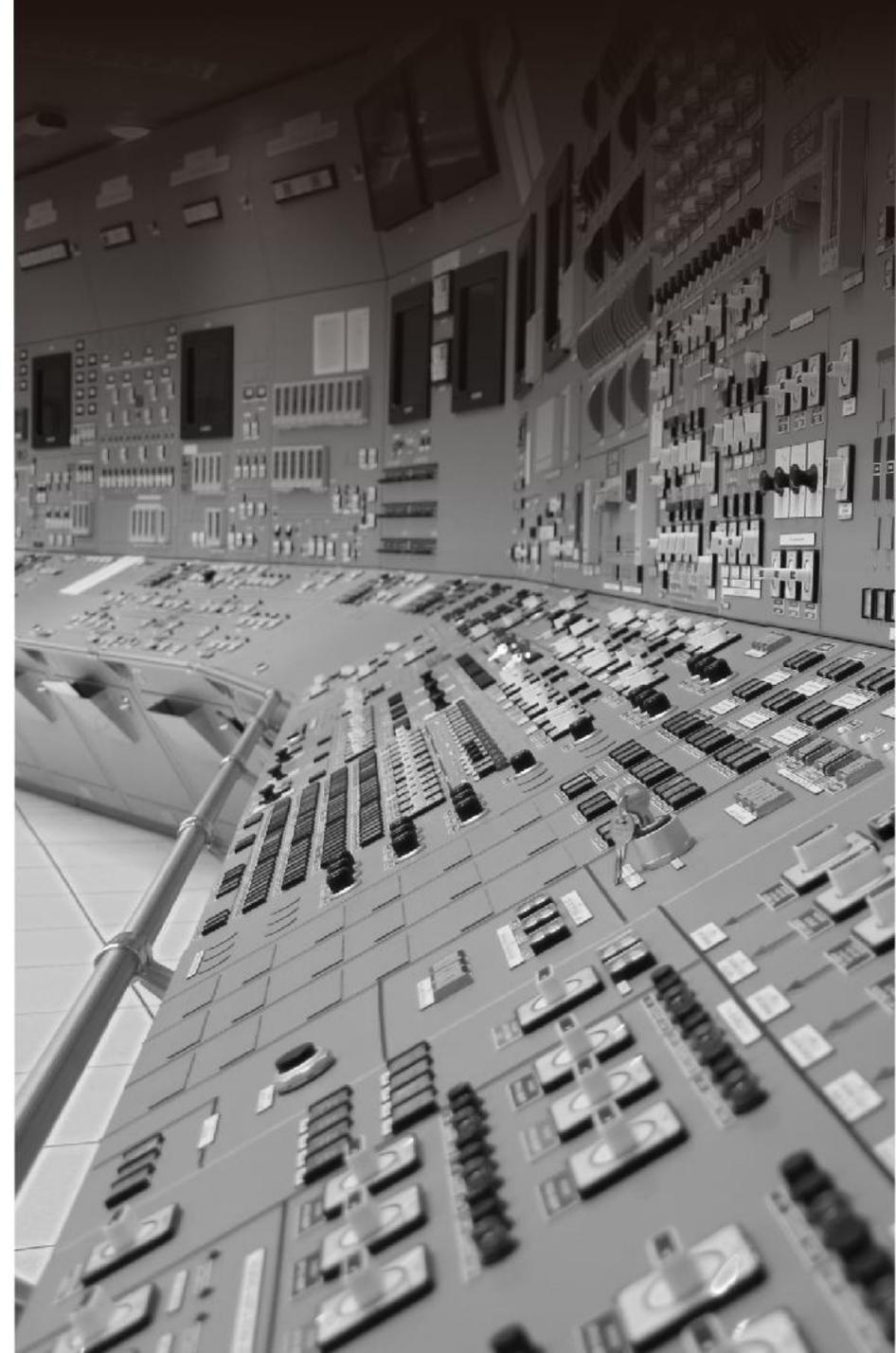
- Clearly defined dates along the process:

  - PSAR to be submitted at least 9 months before construction starts

  - SAR to be submitted 12 months before fuel load

- **CLEARLY THERE IS A REFERENCE PLANT, AN EVOLUTIONARY DESIGN, IN A VERY ADVANCED STATE OF CONSTRUCTION AND TO BE WELL IN AN ADVANCED STATE OF OPERATION WHEN CONSTRUCTION WILL START**
- **CLEARLY THERE IS A DESIGNER AND OEM WITH AN ACTIVE LONG TERM NUCLEAR PROGRAM**

- Therefore 'solutions' from the prescriptive licensing approach are implicitly embedded



# LICENSING OF THE NEXT LARGE NPP

A KNOWLEDGEABLE  
BUYER IN A TURN  
KEY SUPPLY  
ORIGINALLY  
LICENSED IN A  
PRESCRIPTIVE  
APPROACH

NEXT LARGE NPP

Argentinean  
Licensing  
Requirements

Design Authority  
with Long Term  
Program &  
Projection

Reference Plant / Evolutionary  
Design with Proven Solutions



## HIGHLIGHTS OF THE CAREM 25 PROJECT

- CAREM 25 is a Prototype
- CAREM is a LWR based concept but still with many innovations: Integral PCS, natural convection cooling, self pressurization
- First Argentinean NPP entire design
- First Argentinean Manufacturing for most of the NSSS
- Many 'firsts' from a technology, manufacturing, constructability and for (sure) the commissioning and operation / maintenance point of view
- Many Demonstration Facilities built over the years
- 'Evolutions' among Conceptual, Basic and Detail Engineering



## LICENSING APPROACH FOR THE CAREM 25

- CAREM 25 Licensing Approach is clearly based on a 'performance criteria' or safety goal based
- Conceived initially as a 'Non Routine Practice' due to (back then) ongoing evolutions and adjustments in Detail Design / Construction solutions
- CAREM Licensing 'process' is a multi stage one:
  - Authorization for site use and construction – continuous follow up
  - Authorization for fuel load
  - Authorization to perform subcritical core tests
  - Authorization for first criticality
  - Authorization for zero power tests
  - Authorization for increasing power
  - Authorization for full power tests



## LICENSING APPROACH FOR THE CAREM 25

- No due dates once the process is launched (so far) as compared to the case of Large NPPs (see previous slides)
- This conception allowed construction to start in 2013 / 2014
- Evolving, into the same 'licensing' approach used for large NPPs in particular for commissioning and fuel loading and, then operation



# LICENSING OF THE NEXT LARGE NPP

CAREM 25  
PROTOTYPE

**Argentinean Licensing  
Requirements**

**Extensive and Intensive  
Program for V&V – Investment  
in many mock ups and facilities  
for demonstration (30 years of  
dedicated efforts)**

**Design Authority (CNEA) / Government backed  
with strong R&D commitments and history**



# REVOLUTIONIZING THE LICENSING SCHEME FOR SMRs

## SOME DILEMMAS AND THOUGHTS

Is there a conflict?



WISE REGULATOR / RISK AVERSE /  
CONCERNED WITH PROTECTING THE  
PEOPLE AND THE ENVIRONMENT



SMR DESIGNER AND  
VENDOR / RISK TAKER  
TO WIN THE MARKET

**In a business environment where instead of Scaling Up, SMRs are a down scale of the traditional trend**

**Have regulatory issues and policies delayed SMRs?**

Is any licensing process (and the associated licensing criteria) hampering SMRs to become a commercial success? At least for LWR based concepts?

Do we need prototypes?

## COMMENTS, THOUGHTS AND CONCLUSIONS

- 1. Prototyping has been essential for the success of many commercial products...SMRs would not be the exception...they are entirely new products!**
- 2. CAREM 25 Project is today deviating (delayed) from the original Schedule: mainly for cash flow restrictions and eventually for some detail engineering and manufacturing solutions which are unique and were not available except when prototyping. A Design Certification would not have solved them....**
- 3. Like in several (examples are abundant!!! for large NPPs), design certification processes and early Nuclear Regulatory engagements do not solve the actual issues encountered in construction due to incomplete (poor?) detail engineering, bold assumptions and first of a kind issues (shall we look into the EPR or the AP1000 lessons learnt?)... again PROTOTYPING!!!**
- 4. Prototyping seems to be 'necessary' and eventually close to 'sufficient' for a successful licensing (also authorization? certification?) of an SMR**
- 5. Do not expect a successful licensing process to assure commercial projection and profit... many technologically advanced and certified products did not become commercial successes. Regulators look to safety... not electricity produced nor its costs! An SMR concept might be SAFE and still not produce electricity!**

## COMMENTS, THOUGHTS AND CONCLUSIONS

6. 'Abbreviated' licensing processes would be phenomenal, but as we have seen for the next large NPP in Argentina and the CAREM Project, the Regulatory risks comes more from interpretation issues about a common understanding in safety goals and the demonstration of safety (and not in the process or its duration)
7. Nuclear is the most regulated industry, with 'Cold War' legacy visions and approaches...one of them being the 'sovereignty' of the National Nuclear Regulatory Framework, will we overcome this fact? Ever?
8. SMRs need to freeze designs, for a comprehensive framework of Sites and Conditions if they will be massively produced and assembled in factory, will there be a licensing process concurring with this?
9. If so, how a Regulator will handle 'recurring' licensing of the same product if a Prototype has been built?
10. Many SMRs designs have focused a lot in the licensing issue.... But not so much in other aspects that fall under the Regulatory Radar and Scope:
  - SAFEGUARDS
  - SECURITY
  - LOCAL CONTENT AND LOCAL MANUFACTURING (LOCALIZATION AND SERIAL MANUFACTURING OF SAFETY RELATED SSCs
11. Should we look at other regulated industries and see what we can learn?

# Thank You



NUCLEOELECTRICA ARGENTINA S.A.

Secretaría de Energía



Ministerio de Hacienda  
Presidencia de la Nación

