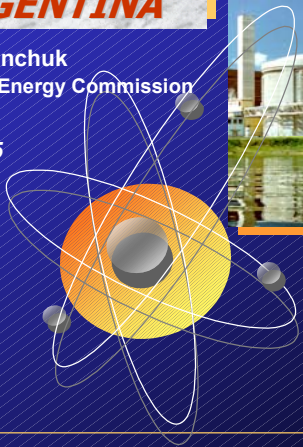


# PRESENT & FUTURE OF NUCLEAR TECHNOLOGY IN ARGENTINA

Dario Jinchuk  
National Atomic Energy Commission

LAS/ANS 2005

June 13-15  
Rio - Brazil



Design: Lic. Stella Spurio

## Nuclear Program in Argentina



- Nuclear Power & Related Supplies
- Medical & Industrial Applications
- Waste Management
- Research & Development
- Human Resources Training

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## NUCLEAR ACTIVITIES (Excluding Medicine)

4.500 Employees  
u\$s 400 millions/year



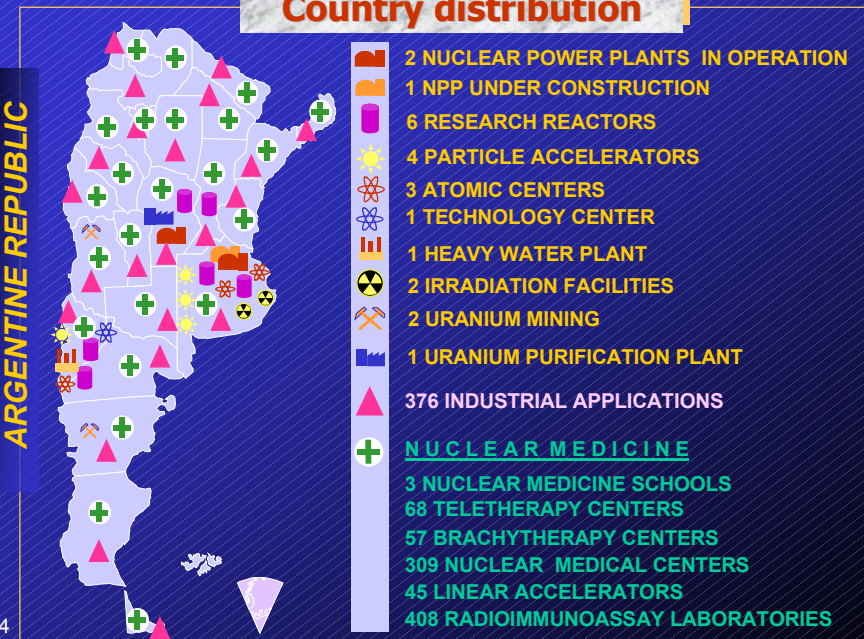
## NUCLEAR MEDICINE (Diagnostics & treatments)

1.500.000 Treatments/year  
1.300 Facilities  
3.000 Employees  
u\$s 200 millions

3

## Country distribution

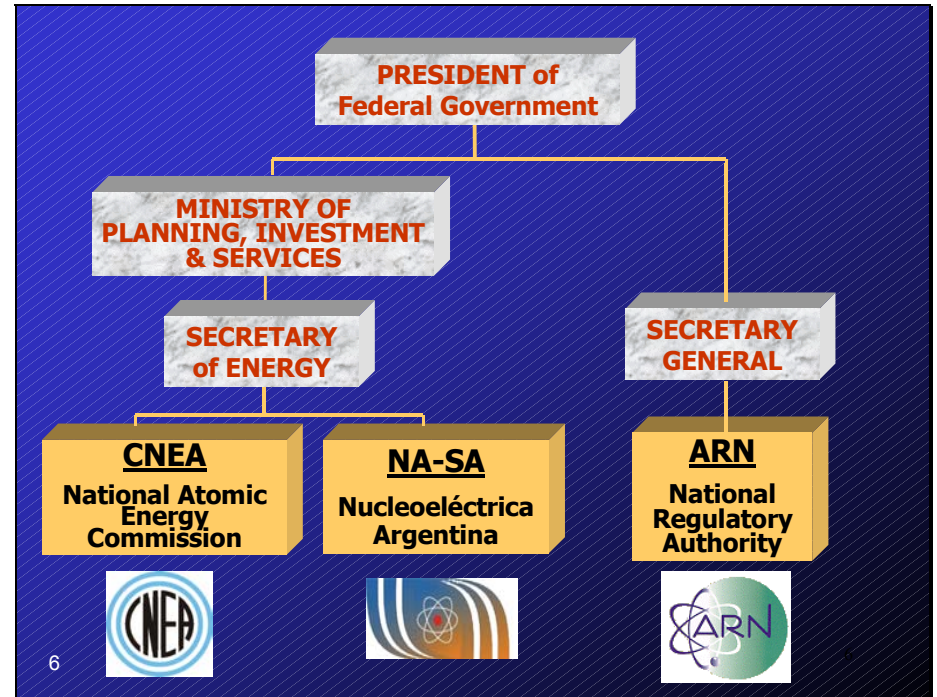
ARGENTINE REPUBLIC



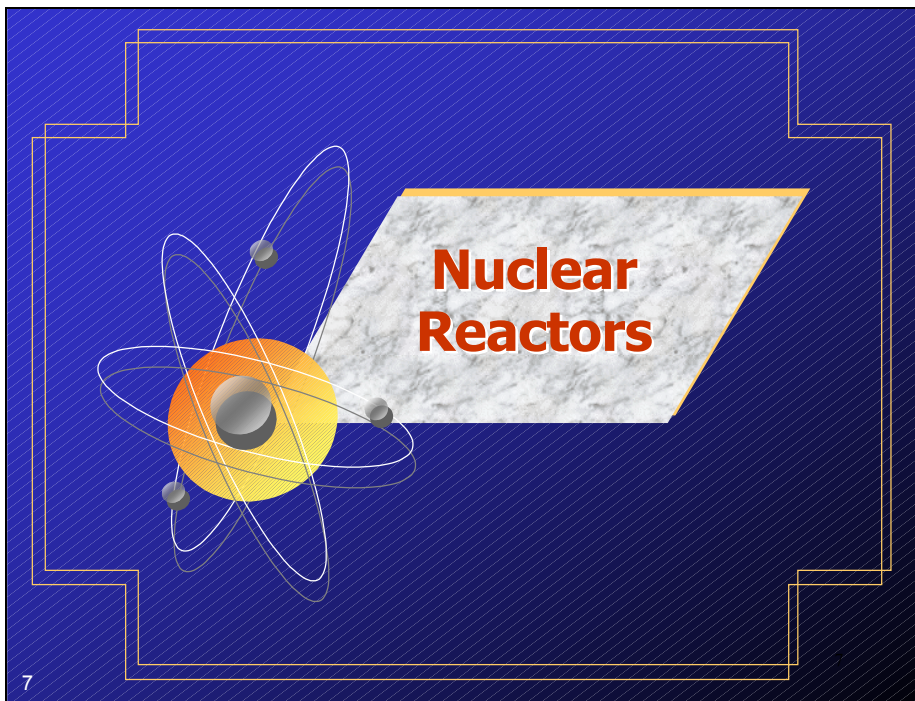
4



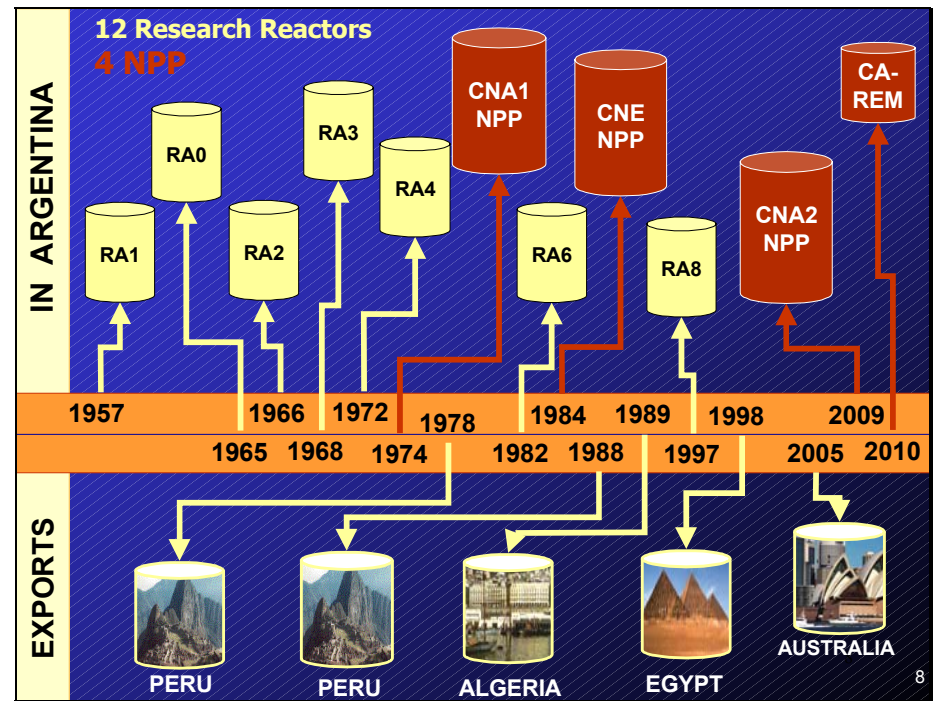
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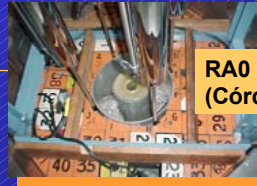
7



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## Research Reactors in Argentina

RA1  
(Buenos Aires)



RA0  
(Córdoba)

RA3  
(Ezeiza)  
10 Mw



RA 6  
(Bariloche)  
0,5 Mw



RA4  
(Rosario)



RA8  
(Pilcaniyeu)

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## Exported Research Reactors

NUR - 1 MW



ALGERIA



RP0 - Critical Assembly



PERU

RP10 - 10 MW



ETRR-II 22 MW



EGYPT



OPAL - 20 MW



AUSTRALIA

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## Nuclear Power Plants in Argentina

ATUCHA 2  
2008  
750 MWe  
Advance: 80%

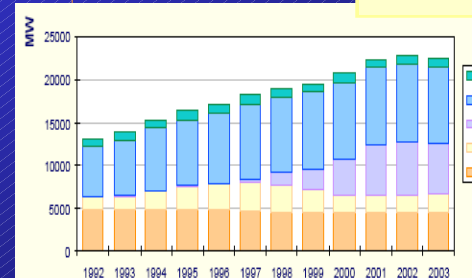
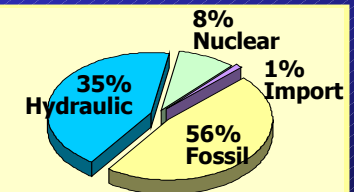
ATUCHA 1  
1974  
350 MWe



EMBALSE  
1984  
600 MWe

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## Power Generation in Argentina



Cammesa / 2004

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# CAREM Reactor

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## CAREM Reactor

- Integrated PWR reactor
- The CAREM Integrated Primary System concept has technical as well as financial advantages compared to traditional designs.
- The USA/DOE Program "Generation IV" selected the CAREM Reactor qualifying it as a "mature design ready to be deployed in the near future".

### PROJECT STATUS

- Engineering finished
- Systems tested
- Prototipe ready to be built

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## CAREM Reactor

Low Power NPP with a new generation, inherently safety, innovative design

- POWER: 25 up to 300 MWe
- COOLING: LW natural convection
- FUEL: Enriched U 3,4 %

1 Control drive	6 SG steam Outlet
2 Control drive rod structure	7 Absorbing element
3 Water level	8 Fuel element
4 Steam generator	9 Core
5 SG water inlet	10 Core support structure

15

## CAREM Reactor

- Passive safety systems
- The simple design of the CAREM Reactor contributes to its high safety level

### Safety Systems

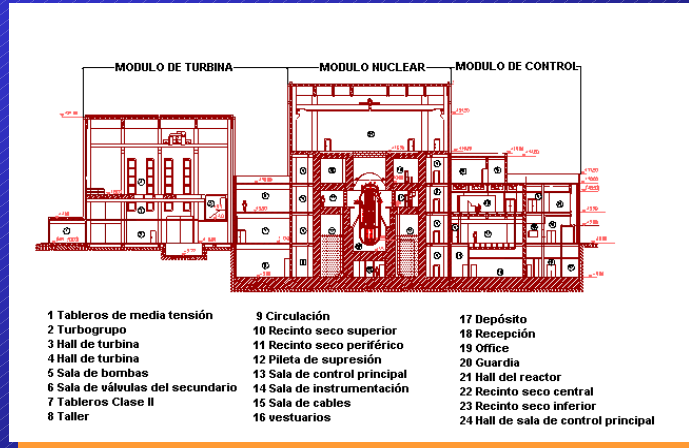
1 - INHIBIT SHUT-DOWN SYSTEM  
2 - SLOWED DOWN SHUT-DOWN SYSTEM  
3 - HEAT EXCHANGE FILM HEAT REMOVAL SYSTEM  
4 - SAFETY BURSTON SYSTEM  
5 - DEPRESSION POOL  
6 - CONTAINMENT  
7 - PRESSURE RELIEF SYSTEM

REFERENCES  
A - CORE  
B - STEAM GENERATOR  
C - BUILDING (BUILDING CONTAINMENT)

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# CAREM Reactor

## Plant Lay-out



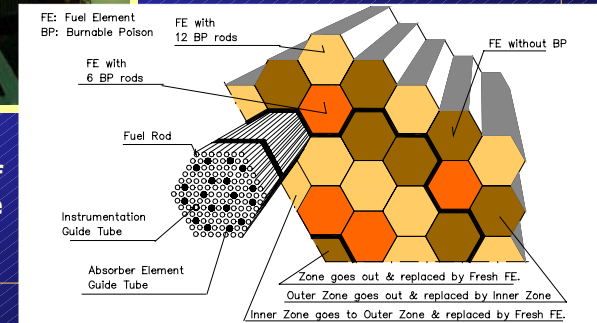
RPV height	11 m
RPV internal diam	3 m

# CAREM Reactor Fuel



**Core: 61 hexagonal fuel elements**  
**Fuel element: 108 rods**  
**Total length: 1,9 m**  
**Pellet diameter: 7.6 mm**  
**Pellet length: 8 mm**  
**Fuel density: 93-95 % TD**

Scheme of CAREM core



# CAREM Reactor

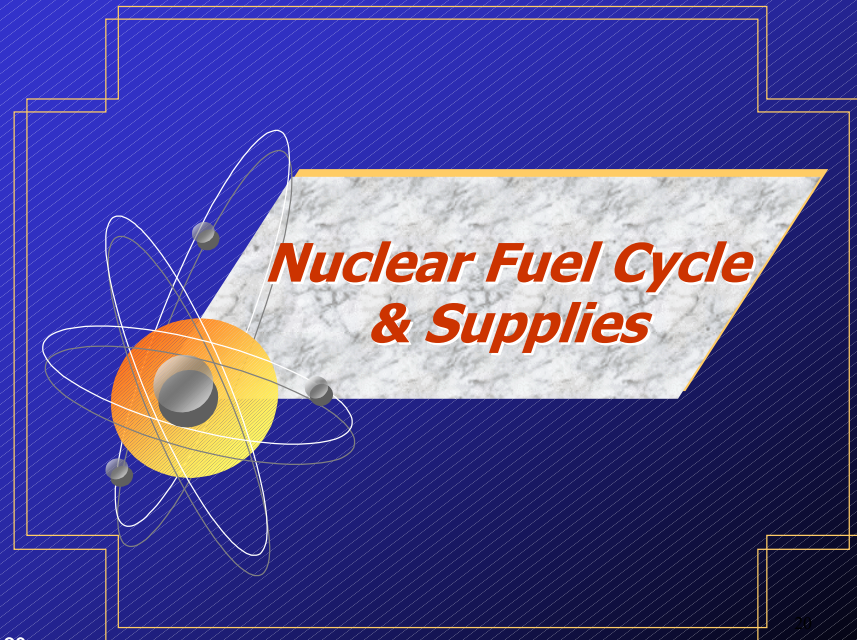
## For water desalination

- **WATER DESALINATION** needs a considerable amount of electricity
- Regular Nuclear Power Plants ranging from 1,000 to 1,400 MWe are larger than needed
- The Low Power Carem Reactor (25 to 300 MWe) is the ideal system to deliver the electricity needed in a water desalination plant



"Several North African and Middle East countries, with growing needs of fresh water, are considering building reverse osmosis desalination facilities powered by small nuclear plants." (Source: IAEA)

# Nuclear Fuel Cycle & Supplies



## Uranium Production



Sierra Pintada Ore

UO<sub>2</sub> Yellow Cake



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## Nuclear Fuel



- Fuels for NPP
- Fuels for Research Reactors
- Special alloys & Zry tubes

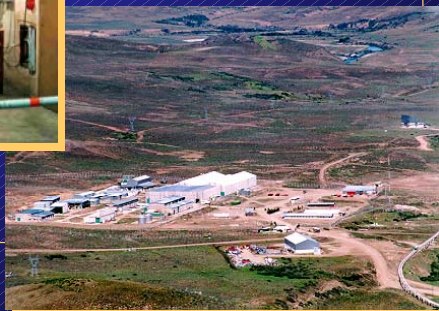


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## Uranium Enrichment Facility



Pilcaniyeu Technological Center



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## Sigma Advanced Uranium Enrichment Diffusion Technology

Project targets

- Total Cost: 50-70 U\$/SWU
- Capital Investment: Up to 25 U\$/SWU
- Energy Consumption: Up to 25 U\$/SWU
- O&M : Up to 5 U\$/SWU
- Availability Factor: > 95 % year
- Cascade Economy Size: 500.000 SWU
- Interconnection Capability in Parallel



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## Slightly Enriched Uranium Fuel

Argentine NPPs were designed to run on Natural Uranium and Heavy Water moderation

- In order to increase burn-up and fuel economy a new fuel element was developed for Atucha 1 NPP employing 0.85 % enriched Uranium.
- From 1999 to 2002 the entire core was replaced.



**Burn-up:** increased from 5,900 to 11,000 Mwd/tU.

**Fuel costs:** 35% lower.



For CANDU type reactors feasibility studies are underway.

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## New fuels for MTR reactors: SILICIDE - UMo

New Uranium Silicide fuel elements for MTR reactors were developed at CNEA



- Prototypes were successfully irradiated and tested in hot cells.
- 64 Fuel Elements are being produced for the Australian Replacement Research Reactor.

$U_3Si_2$   
**Density:** 4,8 gr U/cm<sup>3</sup>  
**Burn-up:** 55%

Uranium-Molybdenum fuels (U-Mo) are under development

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## Heavy Water Production

**Production capacity:** 200 Ton/year

**Purity:** 99.92 %



**EXPORTS**  
S. Korea  
Germany  
Canada  
Norway  
USA  
Australia

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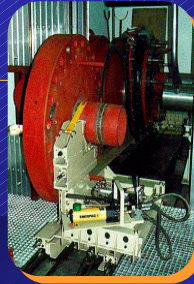
**Products & Services**

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## Services for NPP's



- Non destructive testing
- Repairs in highly radioactive environments
- Design and construction of robots and telemanipulators
- Materials and Fuel testing in Hot Cells
- "Tailor Made" equipment & components



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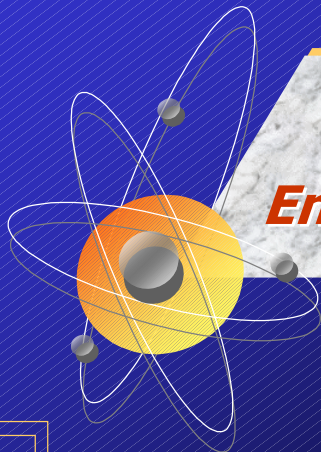
## Products

- Radioisotopes production plants
- Hot cells
- Special Devices
- Facilities & equipments for Nuclear Fuel production
- Shielded Casks for radioactive material transport
- Silos for Spent Nuclear Fuel dry storage



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## Health & Environment



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## Radioisotopes Production



### MTR Reactor

Moly, Iodine, Phosphorous, Samarium, Iridium, Chromium.



### CANDU Reactor

Cobalt-60



### CICLOTRON

Thallium, Fluorine



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## Cobalt 60 Production

- CNEA manufactures Co<sup>60</sup> Industrial and Medical Sealed Sources
- 60 MCi produced at Embalse NPP since 1985. Third worldwide producer
- 90% of production exported through a joint venture with REVISS(UK) and BELFINVEST (Belgium)



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## Mo-99 production

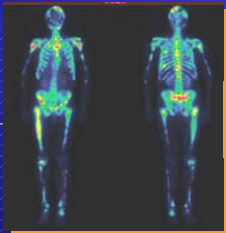
- Argentina was the first country producing Mo<sup>99</sup> by fission employing 20% U<sup>235</sup> enriched targets, instead of the usual 90%
- In our country, 70% of nuclear medical diagnostics employ Mo<sup>99</sup> -> Tc<sup>99</sup> radioisotopes
- Development was successfully completed. Nowadays we are in the serial production phase and negotiating the export of targets and technology



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## Nuclear Medicine Centres

- Equipments
- Facilities
- Software
- Training



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## BNCT Boron Neutron Capture Therapy

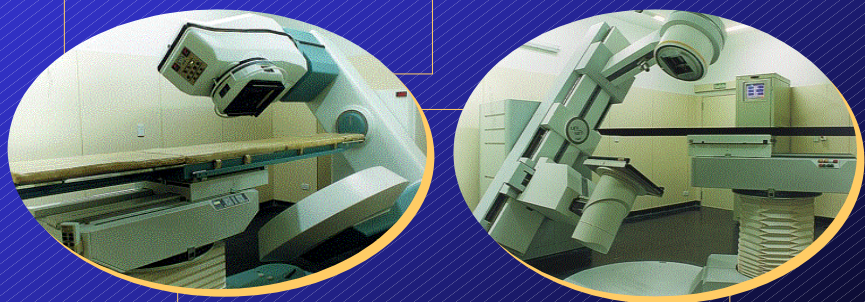
The therapy is mainly employed for malignant brain tumors such as glioblastoma multiform (GBM) and melanomas of different localizations.



In 2003, after a decade of R&D in Argentina, first patients in Latin America were irradiated at the RA-6 reactor (Bariloche Atomic Center).

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## Cobalt therapy Equipment & Simulators

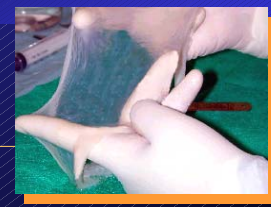


**EXPORTS**  
Bolivia, Colombia  
Venezuela, Syria, Egypt  
India, Brazil

## Irradiation Facilities



- Food preservation
- Sterilization (tissue, implants, surgical instruments)
- Pest control



## Environment

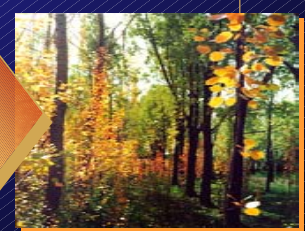
**Spent Fuel  
Management**



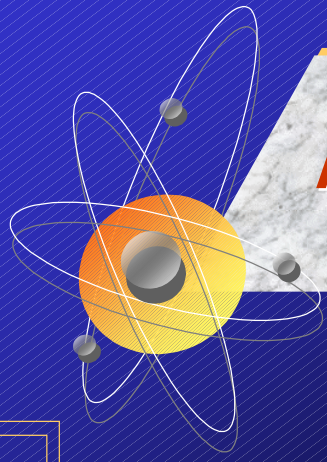
**Radioactive Waste  
Management**



**Environmental  
Remediation**



## Human Resources Training



## Human Resources Training



### 3 Institutes

Atomic Centers  
Laboratories



Agreements with  
National  
Universities  
for academic  
degrees

#### DEGREES

- PhD & MSc in:
  - Physics
  - Nuclear Engineering
  - Materials Science
  - Nuclear Reactors
  - Radiochemistry
  - Mechanical Engineering
  - Nuclear Medicine

- Short Courses in:
  - Nuclear Medicine
  - Radiodosimetry
  - Radiotherapy
  - Radiopharmaceuticals

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## Argentine Nuclear exports to:



USA

Canada

Colombia



Belgium

Germany



UK



Romania



Cuba



Peru



Egypt



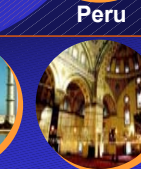
China

Australia

S. Korea



India



Turkey



Algeria

US\$  
700 M

## ATUCHA 2 NPP



LOCATION: Lima (100 km from Buenos Aires City)

OWNER: NA-SA

TYPE: PHWR Natural Uranium

POWER: 750 MWe (Gross)

DESIGN: Siemens

CONST. START: 1981

CONST. STOP: 1994

ADVANCE: 80%

ARGENTINE SUPPLIES: 50%

Atucha 2 NPP - Argentina

## HIGHLIGHTS

- CONTRACT signed 1980 with SIEMENS-KWU.
- TYPE: non turnkey project for the provision of components, engineering and Tech. Transfer.
- ORIGINAL BUDGET: 1881 Mu\$s
- SUPPLIES: 50% Local, 50 % imported

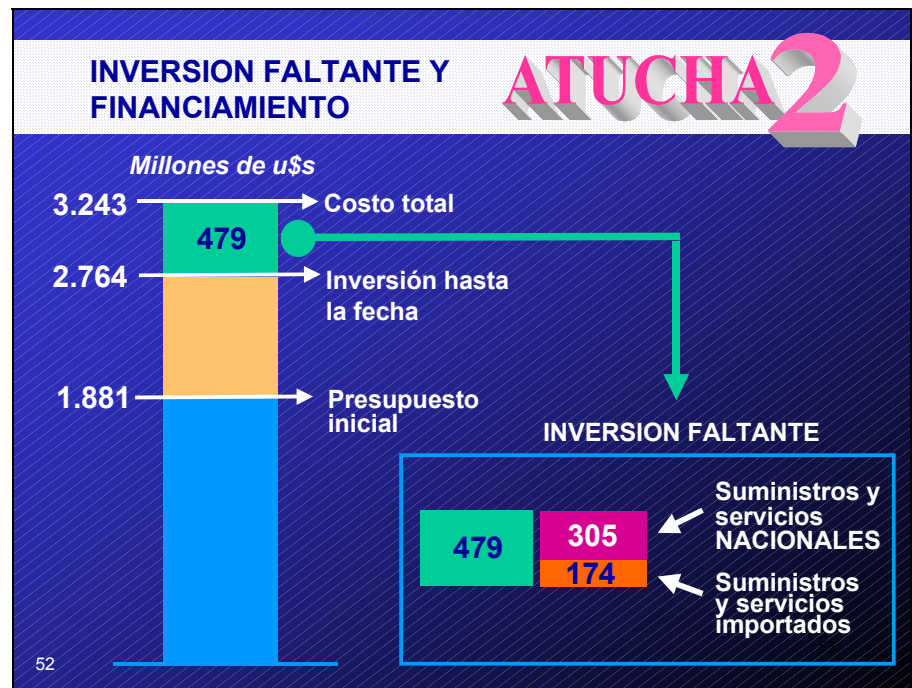
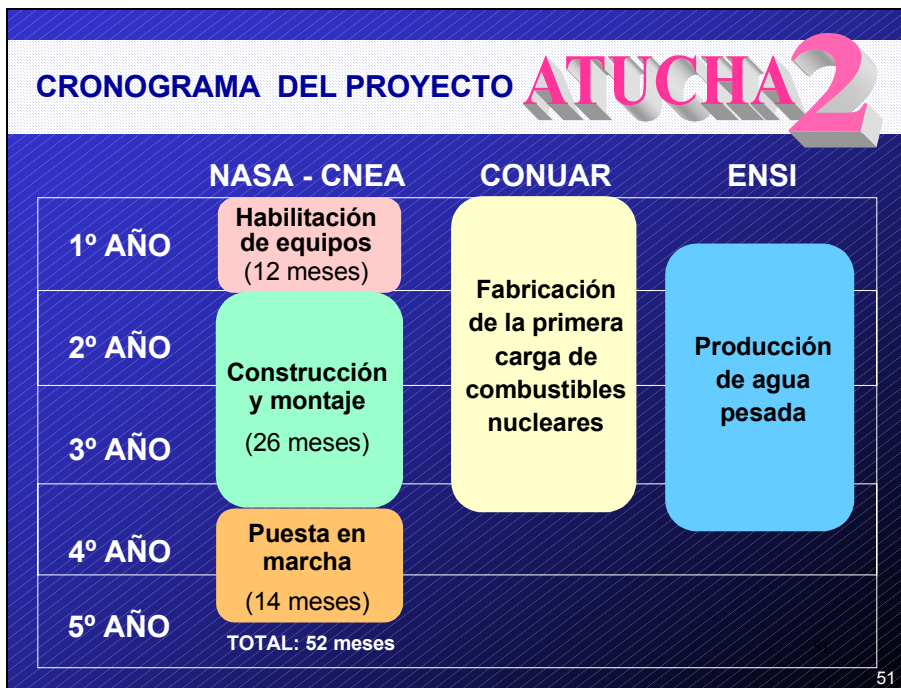
## HIGHLIGHTS (cont)

- CONSTR. Engineer : ENACE (75% CNEA - 25% Siemens - KWU)
- FINANCING: Imported: German Bank loans, Local: Public funds.
- SCHEDULED CONECTION: July 1987

## HIGHLIGHTS (cont)

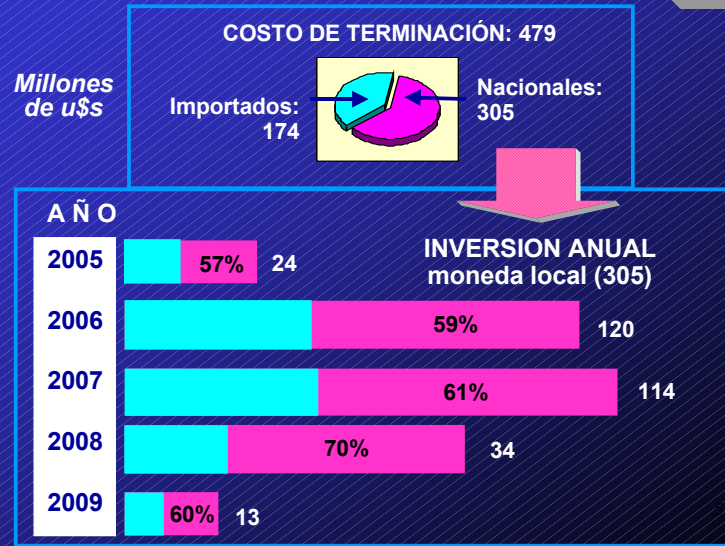
- FIRST POURING: 1981
- PARTIAL DELAYS DUE TO FINANCIAL PROBLEMS WITH LOCAL FUNDS: 1983/5-1987/90.
- TOTAL STOP: 1994
- REINITIATION: 2005?





## INVERSION FALTANTE Y FINANCIAMIENTO

# ATUCHA 2



## SECRETARIO DE ENERGIA D. CAMERON

31-05-05

“Por directivas del presidente de la Nación comenzamos a profundizar los análisis sobre la situación y a tomar definiciones concretas sobre el sector nuclear”.

“Esperamos, con la culminación de Atucha II, la puesta en funcionamiento de la planta de agua pesada y la vuelta del sector a la actividad minera, recrear los incentivos para que el sector desarrolle en plenitud una nueva oportunidad”

“Atucha II está actuando como un calibre “pasa no pasa”; sólo si somos capaces de terminarla,  aun solos, el sector nuclear en la Argentina tendrá destino”.



**NUESTRO DESAFIO INMEDIATO ES TRABAJAR PARA QUE LA AGENDA POLITICA COMIENZE A CONSIDERAR LA OPCION NUCLEAR EN LA REGION**

*Thank you  
very much  
for your attention !!*



**National Atomic  
Energy  
Commission**

[www.cnea.gov.ar](http://www.cnea.gov.ar)



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## Central Nuclear Atucha II

- **Objeto:** negociaciones con plazo no mayor de 6 meses para garantizar continuidad y finalización de la obra

- **Cronograma de Inversiones (M u \$s)**

Suministros y Servicios	2005	2006	2007	2008	2009	Total
Importados	18	60	55	28	13	169
Nacionales	50	107	101	34	13	305
Total	68	167	156	62	26	479

Ministerio de Planificación Federal, Inversión Pública y Servicios - Secretaría de Energía

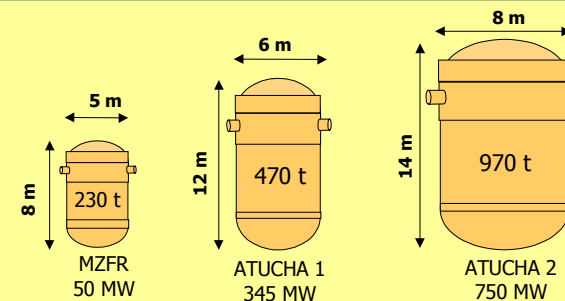
**Atucha 2 NPP  
PHWR  
750 Mwe**

**Atucha 1 NPP  
PHWR  
345 Mwe**

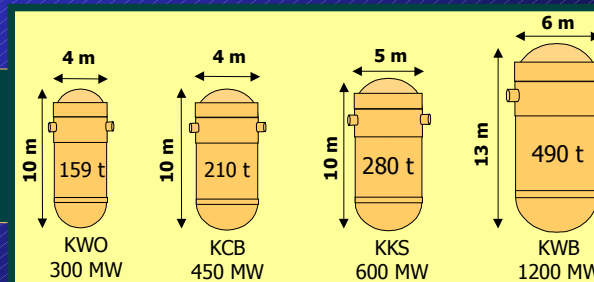


Atucha 2 NPP - Argentina

### PHWR



### PWR



Atucha 2 NPP - Argentina

