

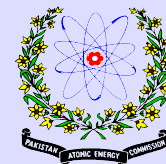
# Nuclear Power Program of Pakistan and Nuclear Safety

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Pakistan Atomic Energy Commission

The 3<sup>rd</sup> ASEM Seminar on Nuclear Safety, “Effective,  
Transparent and Sustainable Nuclear Safety  
Infrastructure”

Yogiakarta, 4-6 November 2014

# Major Milestones in Development of Nuclear Power in Pakistan



A major advance by a developing country in the peaceful application of nuclear technology

KANUPP starts commercial operation



**137 MW KANUPP**

Canada unilaterally withdraws vendor support for KANUPP – Other restrictions as well

**KANUPP fuel bundle**



**1965**

Commercial contract signed with Canada for 137 MW Karachi Nuclear Power Plant KANUPP

**1972**

Pakistan becomes the 15th Country to have commissioned a nuclear power plant

**1976**

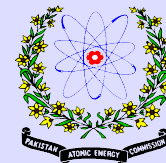
PAEC initiates a self reliance program for fuel and spare parts fabrication

**1980**

First indigenous fuel bundle loaded in KANUPP

**All Pakistani fuel by 1990**

# Major Milestones in Development of Nuclear Power in Pakistan



A few windows opened as Pakistan became member of WANO and COG



C-1, Pakistan's second nuclear power plant connected to grid – the first from China

Pakistan Nuclear Regulatory Authority created

1989

**WANO:** World Association of Nuclear Operators

and

**COG:** CANDU Owners Group

1991

Contract signed for C-1

**Start of South-South Cooperation**

2000

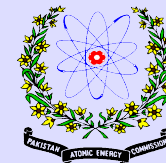


**325 MW C-1**

2001



# Major Milestones in Development of Nuclear Power in Pakistan



Contract signed for **C-2**



2004

KANUPP re-licensed beyond design life



Pakistan Energy Security Plan allocated 8,800 MW to nuclear by 2030

2005



**C-2 Commercial Operation**  
May 11 inauguration by the Prime Minister

2011



First Concrete Pour **C-3**



2011

First Concrete Pour **C-4**

# Current Status of Nuclear Power: Pakistan



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Nuclear Power Plants	Capacity (MWe)	Year of Commissioning
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## ❑ In Operation

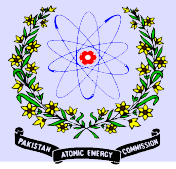
KANUPP	137	1972
CHASNUPP-1	325	2000
CHASNUPP-2	325	2011

## ❑ Under-construction

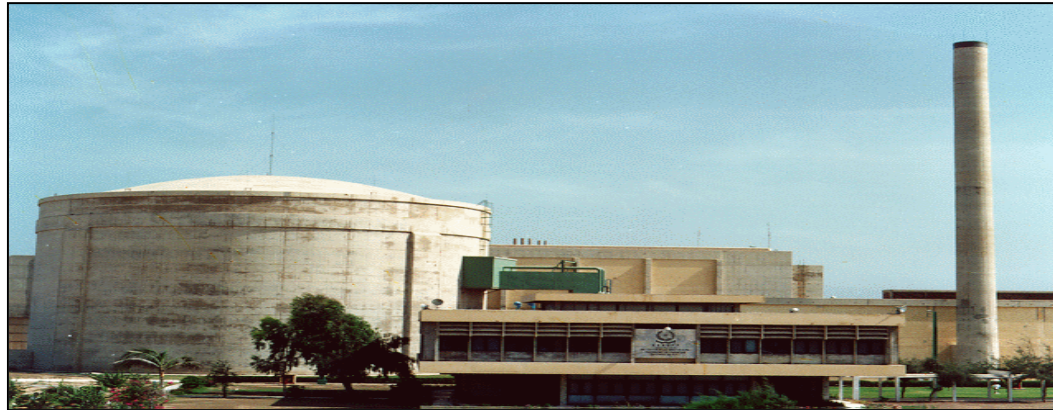
CHASNUPP-3	340	2016
CHASNUPP-4	340	2017

## ❑ Contract Finalized

KII	1000	2021
KIII	1000	2021



# KANUPP



- ❑ Type : CANDU-Pressurized Heavy Water Reactor
- ❑ Commercial operation : 1972
- ❑ Contract : Turn-key with Canadian General Electric (CGE), Canada
- ❑ Power : Design: 137 MWe  
(Now restricted to 90 MWe)

On commissioning of KANUPP, Pakistan became:

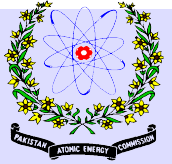
The 15th country of the world to have a nuclear power plant

# KANUPP: Self Reliance



- ❑ Vendor support was stopped in 1976. Other developed countries also imposed embargoes on transfer of nuclear technology to Pakistan
- ❑ This initiated a self-reliance program leading to:
  - Development of indigenous fuel
  - Development of technical support system including fuel management and safety assessment
  - Manufacturing of spare parts
- ❑ KANUPP operated safely, completed its design life in 2002 and was re-licensed after a number of safety retrofits had been carried out.

# Construction of Second Nuclear Power Plant



- ❑ Despite keen interest, it took some two decades to begin construction of the second nuclear power plant mainly because of international embargoes
- ❑ Development of the nuclear power industry in China opened a window for Pakistan
- ❑ A contract was signed with China on December 31, 1991 for a 325 MWe PWR at Chashma - CHASNUPP -1



# Chashma Nuclear Power Plant (Unit 1: C-1)



- ❑ Construction Started on : August 1992
- ❑ Constructed by : China National Nuclear Corporation
- ❑ Commercial operation : September 2000
- ❑ Type/Size (MW) : Pressurized Water Reactor, 325
- ❑ Operation & Maintenance : By PAEC
- ❑ Capacity factor last 3 years : 85.0%

# Chashma Nuclear Power Plant (Unit 2: C-2)



- ❑ Construction Started on : Dec 2004
- ❑ Constructed by : China National Nuclear Corporation
- ❑ Commercial operation : May 2011
- ❑ Type/Size : Pressurized Water Reactor, 325 MW
- ❑ Operation & Maintenance : By PAEC

# Chashma Nuclear Power Project (Units 3 and 4: C-3/C-4)



Size and Type: 2x340 MW Pressurized Water Reactors

Contractor: China National Nuclear Corporation

	C-3	C-4
Contract Signing	20 Nov 2008	20 Nov 2008
Contract Effective Date	31 Mar 2010	31 Mar 2010
Groundbreaking	5 Aug 2010	1 Apr 2011
First Concrete Pouring	4 Mar 2011	18 Dec 2011
IAEA Approval of Safeguards	8 Mar 2011	8 Mar 2011
Commercial Operation (as per contract)	31 Dec 2016	31 Oct 2017

# Social uplift of Local Population (Chashma Site)



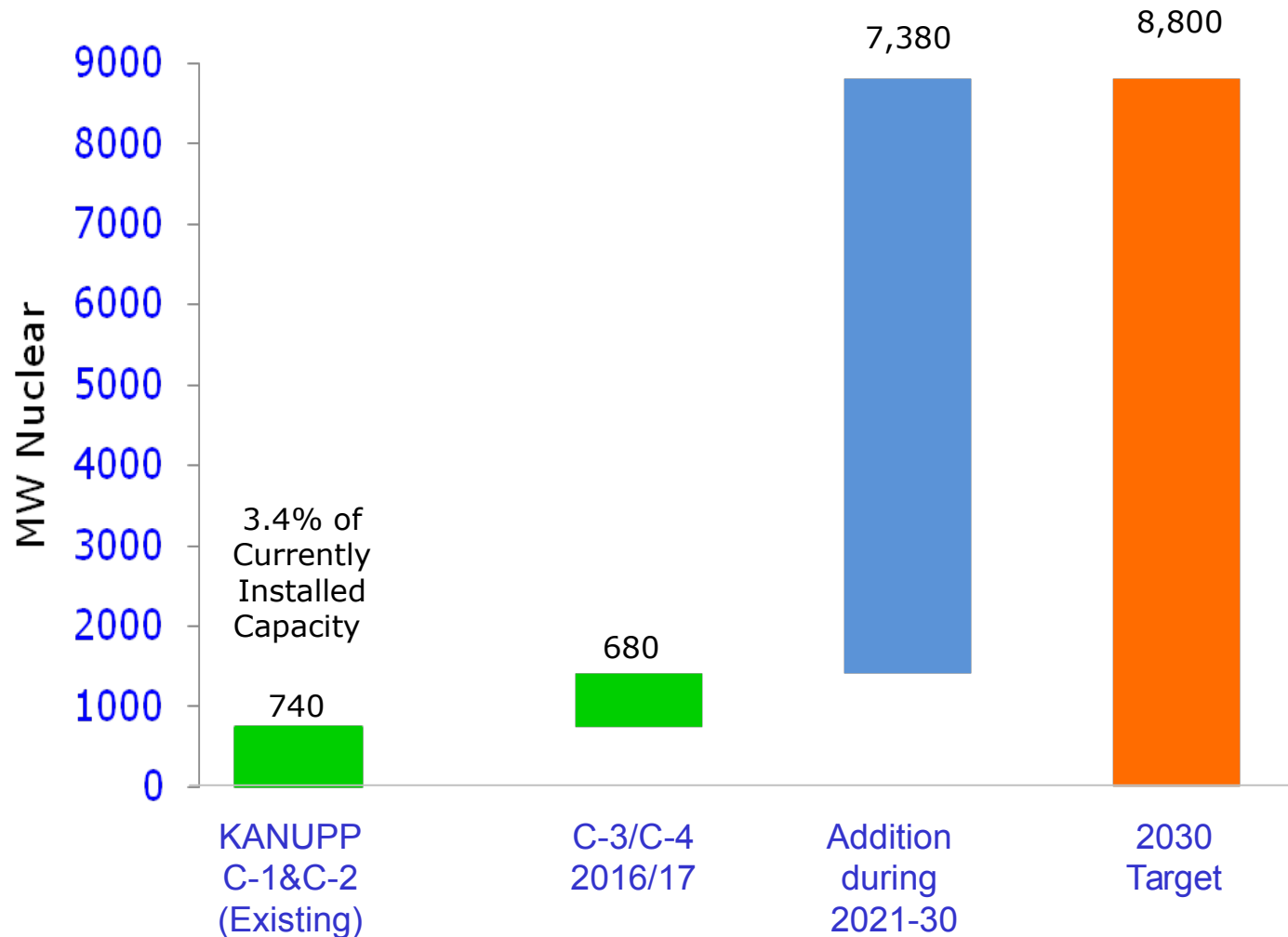
- ❑ Share of employees from  
Mianwali District : 48%
  
- ❑ Local patients treated in PAEC  
hospital in 2010-11 : 1600
  
- ❑ Local students in PAEC schools : 950
  
- ❑ Spending millions of Rupees by employees in local  
markets creating/expanding economic activities

# Need for Expansion of Nuclear Power

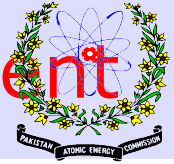


- ❑ Track record
  - High capacity factors (C-1, 229 days continuous operation)
- ❑ Economical option
  - NPP generates electricity at lower cost than oil-fired, coal-fired and imported gas based plants
- ❑ Enhance energy security
  - Fuel can be stored for 2-3 years
- ❑ Stability in electricity price
  - Electricity generation cost is relatively insensitive to market fluctuations of fuel cost (because of low share of fuel cost in generation cost)
- ❑ Environment friendly source of power
  - No acidic and greenhouse gas emissions
- ❑ Provides energy diversity

# Nuclear Power Program as per Medium Term Development Framework



# Human Resource Development



- ❑ Pakistan Institute of Engineering and Applied Sciences (PIEAS)
  - Masters and Ph.D programs in engineering and sciences
  
- ❑ Karachi Institute of Nuclear Power Engineering (KINPOE)
  - Masters, Post-Graduate and Post-Diploma programs in nuclear power technology
  
- ❑ CHASNUPP Centre of Nuclear Training (CHASCENT)
  - Post-Graduate and Post-Diploma programs
  - Training for licensing of PWR Operations Shift Supervisors using a full scope training simulator
  
- ❑ National Centre for Non-Destructive Testing and Pakistan Welding Institute

# Safety of Nuclear Power Plants



- ❑ Pakistan has been safely operating its NPPs with continuing effort to develop and improve safety culture, further.
- ❑ To ensure safe operation of NPPs, we have safety committees at the plant level, and a Safety Directorate at the corporate level.
- ❑ At National Level PNRA controls, regulates and supervises all the matters related to safety of NPPs in Pakistan, independently.
- ❑ Pakistan is party to various international conventions on nuclear safety.



# How We Ensure Safety



- Safety by Operation
- Safety Culture
- Internal Safety Assessments
- Human Factor
- Quality Assurance
- Regulatory Control

# Safety by Operation



- Safety Policy
- Operational limits and conditions
- Qualification and training of personnel
- Exchange of information on operational events (INPO and WANO)
- Performance of safety related activities
- Documentation of all operational procedures (SOPs)
- Control of plant configuration
- Periodic Safety Review
- Ageing Management
- Emergency Preparedness Program
- Accident Management Program

# Safety Culture



- ❑ We have a well developed Safety Culture Program to develop core values and behaviors from a collective commitment by leaders and individuals to emphasize safety and safety culture.

# Internal Safety Assessments



- We have safety committees at the plant level
- And a Safety Directorate at the corporate level.

Through these we carry out Internal Safety Assessments at regular intervals.

# Human Factor

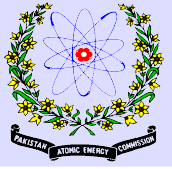


- ❑ We have established clear interfaces between man and machines
- ❑ We have prepared operating and emergency procedures and maintenance rules and guidelines.
- ❑ Human intervention, even in extremely degraded situations, implemented by adequate training, procedures and simulation studies and practices

# Full Scope Training Simulator for C-2



# Quality Assurance



- ❑ Safe operation, maintenance and construction of nuclear plant/facilities requires stringent quality control and quality assurance programs at all levels.
- ❑ Implementation of systematic Quality Assurance program guarantees safety of plant equipment and personal.
- ❑ All Nuclear Projects are subject to three levels of QA Audit/Surveillance
  - Plant/Project level QA
  - Corporate Level QA
  - QA by Regulatory Authority
- ❑ Peer Reviews by WANO and IAEA

# Regulatory Control



- We have an Independent Regulatory Body (PNRA)
- Responsibilities of the PNRA are to
  - License and certify
  - Set the detailed safety objectives and standards
  - Monitor and enforce them
  - Assess and Investigate the events
  - Perform research activities
  - Communicate any information concerning safety to the public
  - Communicate its regulatory decisions and opinions to the public



# Safety Documents



- ❑ The safety Documents evaluated by PNRA are as follows
  - ❑ The probabilistic safety evaluation (PSA).
  - ❑ The environmental impact assessment (EIA).
  - ❑ Preliminary Safety Analysis Report (PSAR)
  - ❑ Final Safety Analysis Report (FSAR)
  - ❑ The external emergency plan.
  - ❑ The operation manual, including the emergency procedures.
  - ❑ The operation organization document.
  - ❑ The pre-operational test program.
  - ❑ The technical specifications for operation.
  - ❑ The periodic safety reviews.

# PAEC Response to Fukushima



- ❑ Fukushima Response Action Plan
  - Immediate
  - Short-term
  - Long-term
- ❑ Main elements of the action plan
  - Re-assessment of external hazards
  - Additional sources of emergency power
  - Diverse means of core cooling
  - Comprehensive emergency preparedness plan
- ❑ Implementation and Monitoring
  - Internal safety reviews by independent group
  - Review of KANUPP action plan by COG

# Concluding Remarks



- ❑ Pakistan is a pioneer developing country in using nuclear technology for producing electricity.
- ❑ Nuclear power can play a significant role in providing base-load electricity and minimizing imports of expensive fossil fuels.
- ❑ Despite international embargoes, nuclear power program in the country is moving forward - slowly but steadily to achieve the target of 8,800 MW by 2030.
- ❑ Safety will remain on top priority in the nuclear power program of Pakistan.

The image features two horizontal bars. The top bar is composed of a red segment on the left and a teal segment on the right. The bottom bar is composed of a teal segment on the left and a red segment on the right. The text "THANK YOU" is centered between these two bars.

**THANK YOU**