NPP Construction/Operation & Nuclear Technology Development : Experience from South Korea

22 AUG 2017

KHNP

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KHNP

1 Status of Nuclear Industry in Korea

KHNP Overview

Business Area	Nuclear, Hydro, Pumped Storage, Renewables
Employee	11,200 Persons
Credit Rating	AA(S&P), Aa2(Moody's)
Total Assets	$ 46.5 Billion
Revenue/Net Income	$ 9.9 Billion / $ 2.2 Billion

Nuclear
Op. unit : **24**
Capacity
22.5 GW

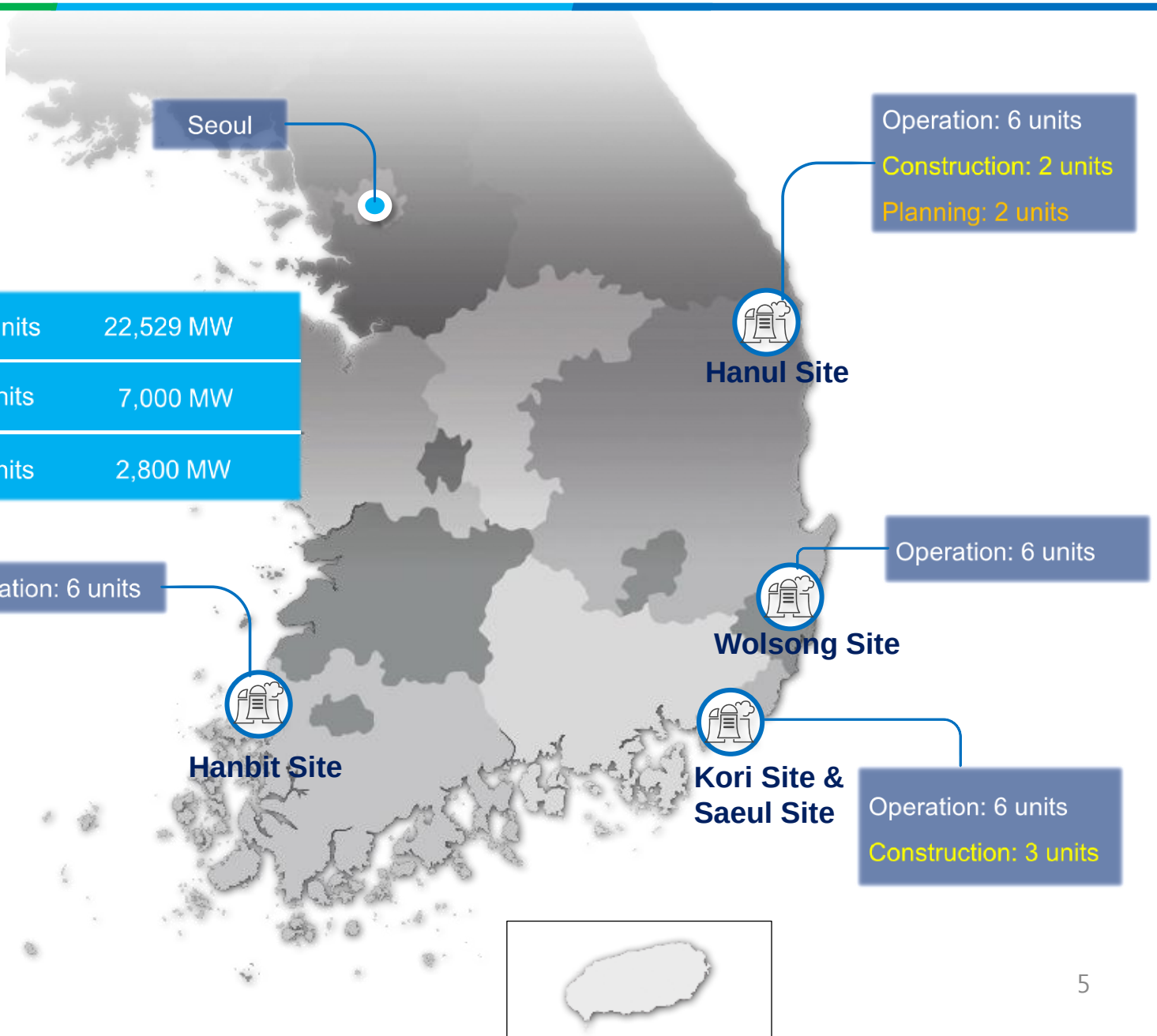
Hydro
Op. unit : **35**
Capacity
0.6 GW

Pumped Storage
Op. unit : **16**
Capacity
4.7 GW

Renewable
Op. unit : **7**
Capacity
0.1 GW

NPPs In Korea

Operation	24 units	22,529 MW
Construction	5 units	7,000 MW
Planning	2 units	2,800 MW



Operating Plants

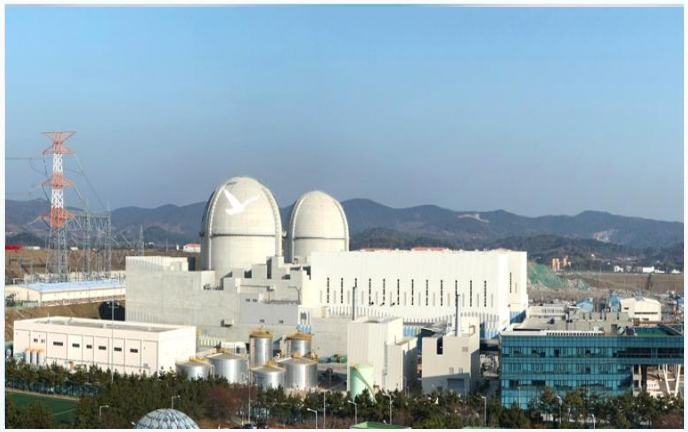
Kori 2,3,4 / Shin-Kori 1,2,3

Hanbit 1,2,3,4,5,6

Wolsong 1,2,3,4 / Shin-Wolsong 1,2

Hanul 1,2,3,4,5,6

Plants Under Construction



Shin-Kori 4

Shin-Hanul 1, 2

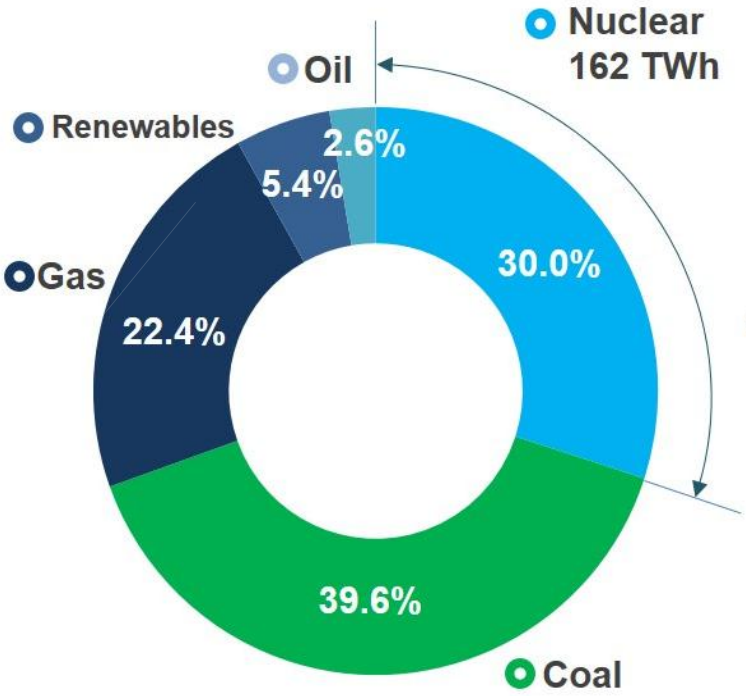
Shin-Kori 5, 6

Planning Plants(2)

Korea's Electricity Status

Nuclear power accounts for about 30.0% of gross electricity generation

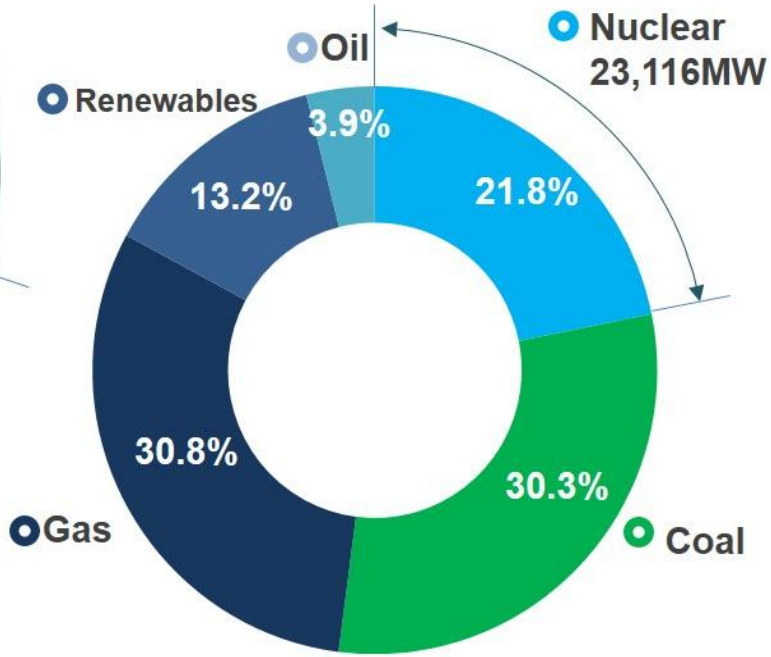
Electricity Generation



TOTAL : 540 TWh

※ Source : KHNP website

Installed Capacity

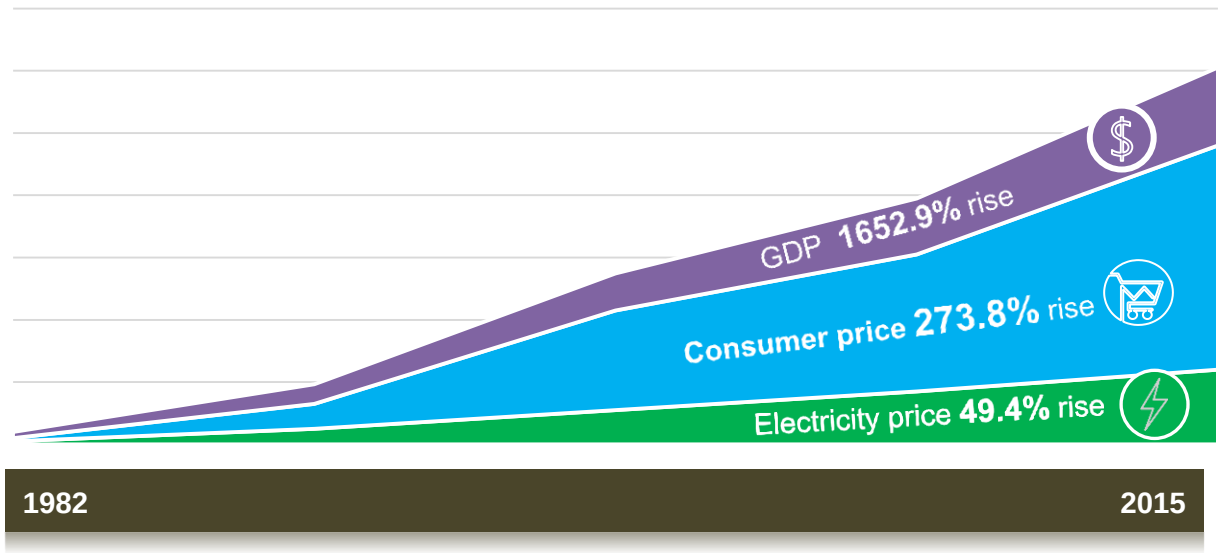


TOTAL : 105,866 MW

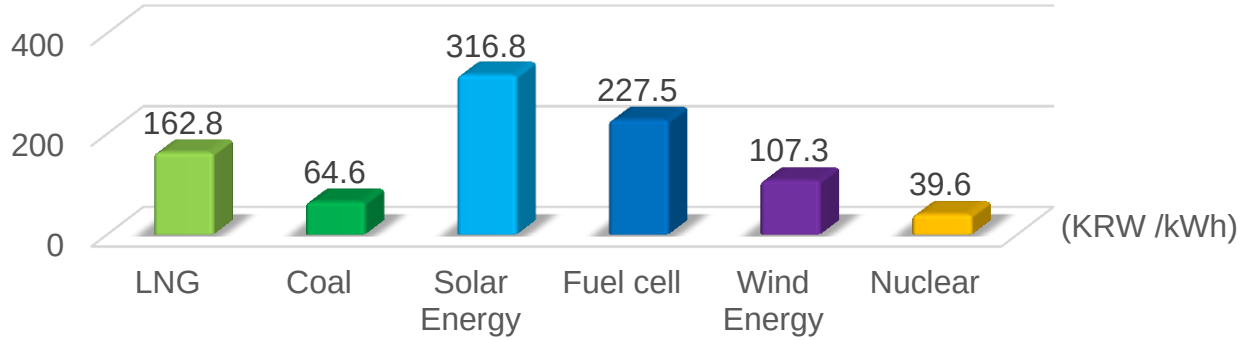
NPP's Role in Korea's Economic Growth

Nuclear is the most affordable energy in Korea

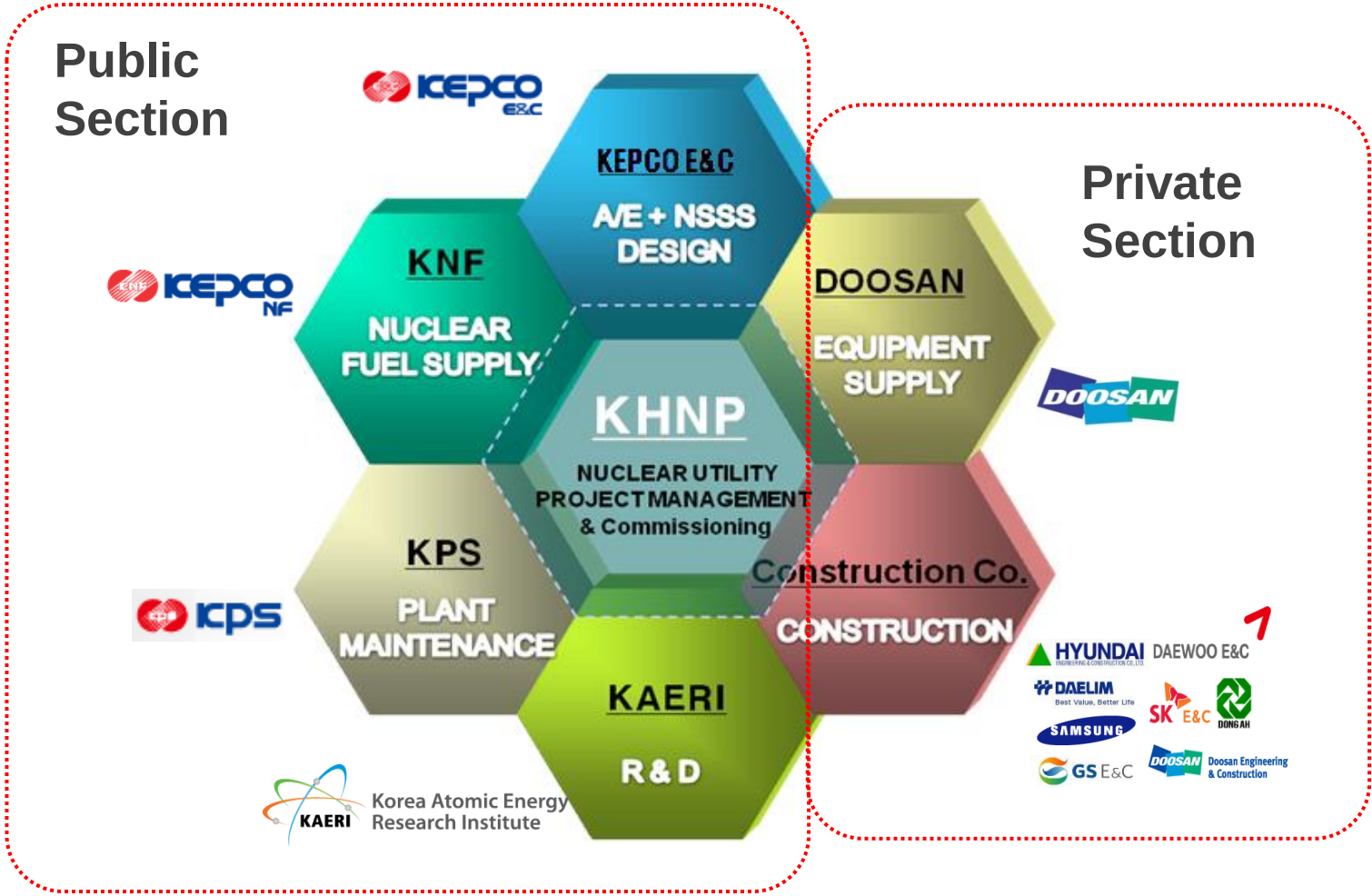
NPP Led to Economic Growth with Low Electricity Price



Unit price by energy source(2014)



Robust Nuclear Industry



- Strong Project Management Ability
- World-Class NPP Operating Ability
- Economical
- Short Construction Period

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Robust Supply Chain

Robust Supply Chain

Many Nuclear Suppliers & Materials

Supplier : 80,000 Companies

- Collaboration System
- Purchase through Competition
- Evaluation

Material : 550,000 Items

- Material Attribute Information
- Optimal Inventory Control
- Material Allowance for SPV* items
- Quality Material Management

* SPV : Single Point Vulnerability

Annual Procurement

Purchase Request	Order	Purchasing Material	Payment
8,000	20,000	100,000	$ 3.2 B

Qualified Suppliers

Quality Class	Auxiliary Equipment	Spare Part	Service	Others
Q	205	462	150	260
A	70	204	24	282
Total	275	666	174	542

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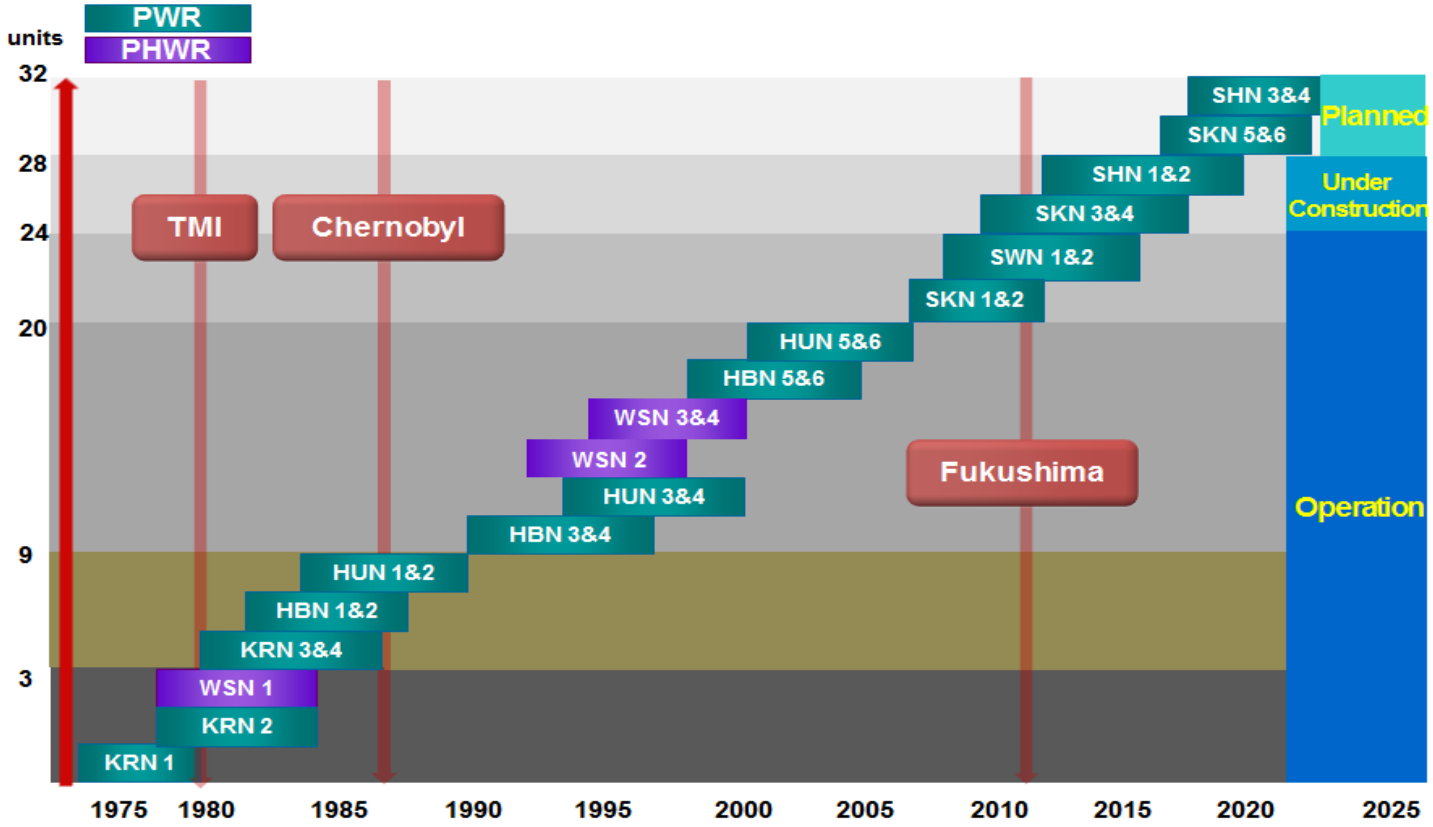
2 Construction & Operation Experience

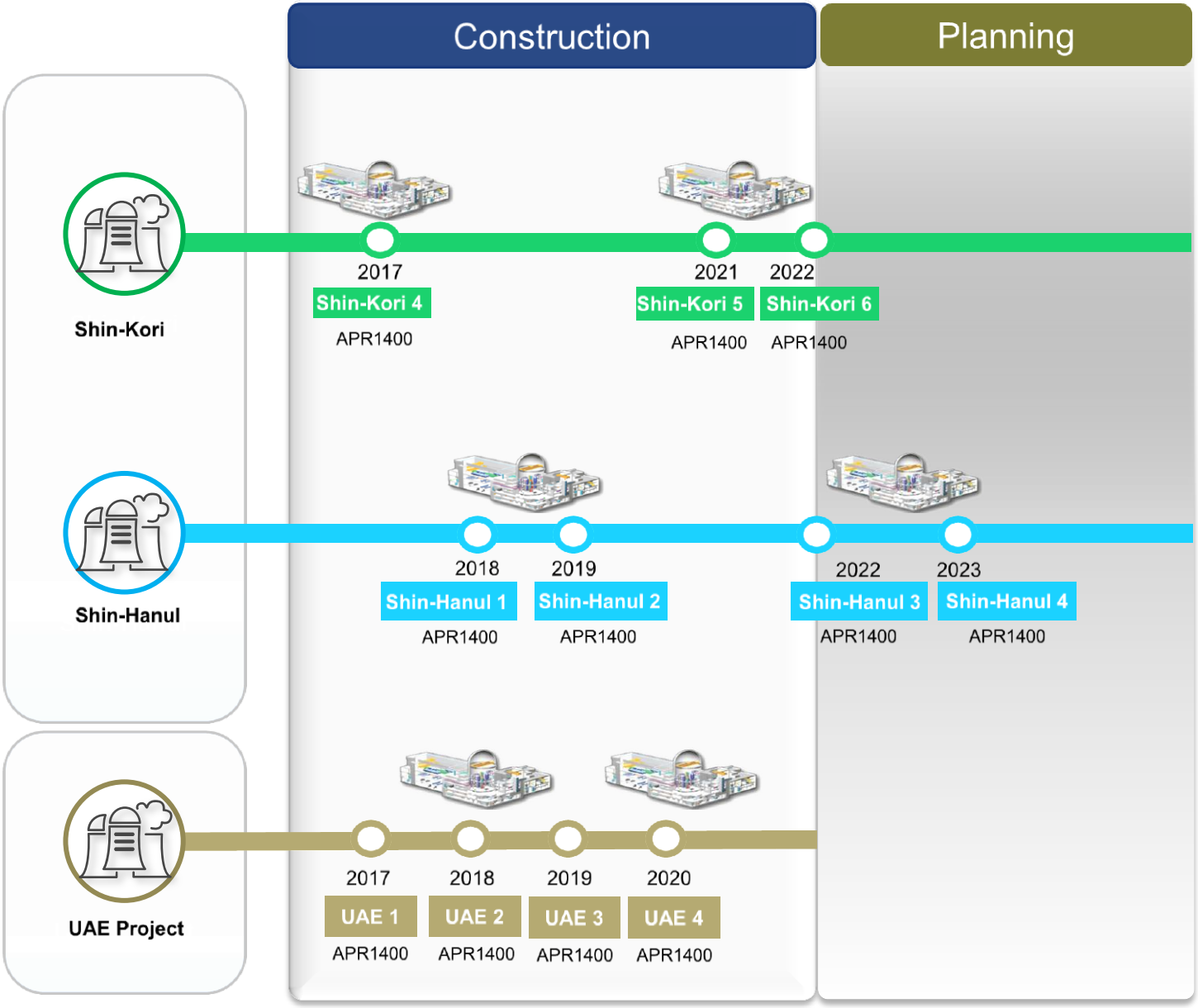
Continuous Construction

Continuous Construction of 25 NPPs for 40 years

- Completed 25 NPPs from Kori #1(1978) to Shin-kori #3,
- Persistent NPP Construction despite Nuclear Accidents



NPP Construction Projects



Competitive-ness

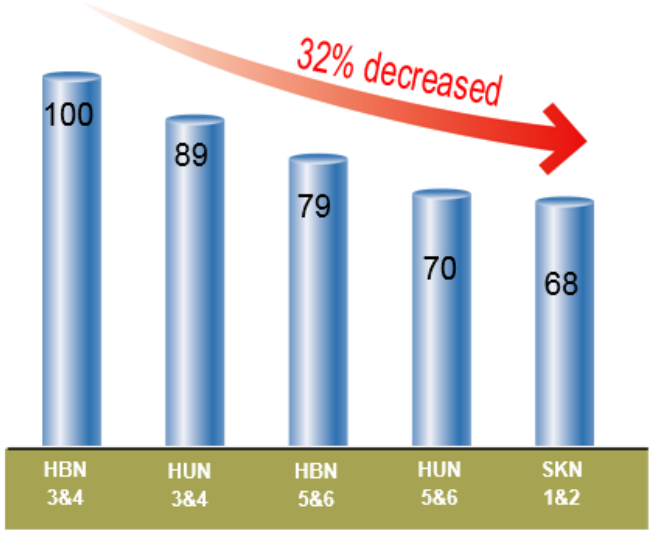
NPP	COD
HBN3	`95.3
HBN4	`96.1
HUN3	`98.8
HUN4	`99.12

NPP	COD
HBN5	`02.5
HBN6	`02.12
HUN5	`04.7
HUN6	`05.4

NPP	COD
SKN1	`11.2
SKN2	`12.7
SWN1	`12.7
SWN2	`15.7

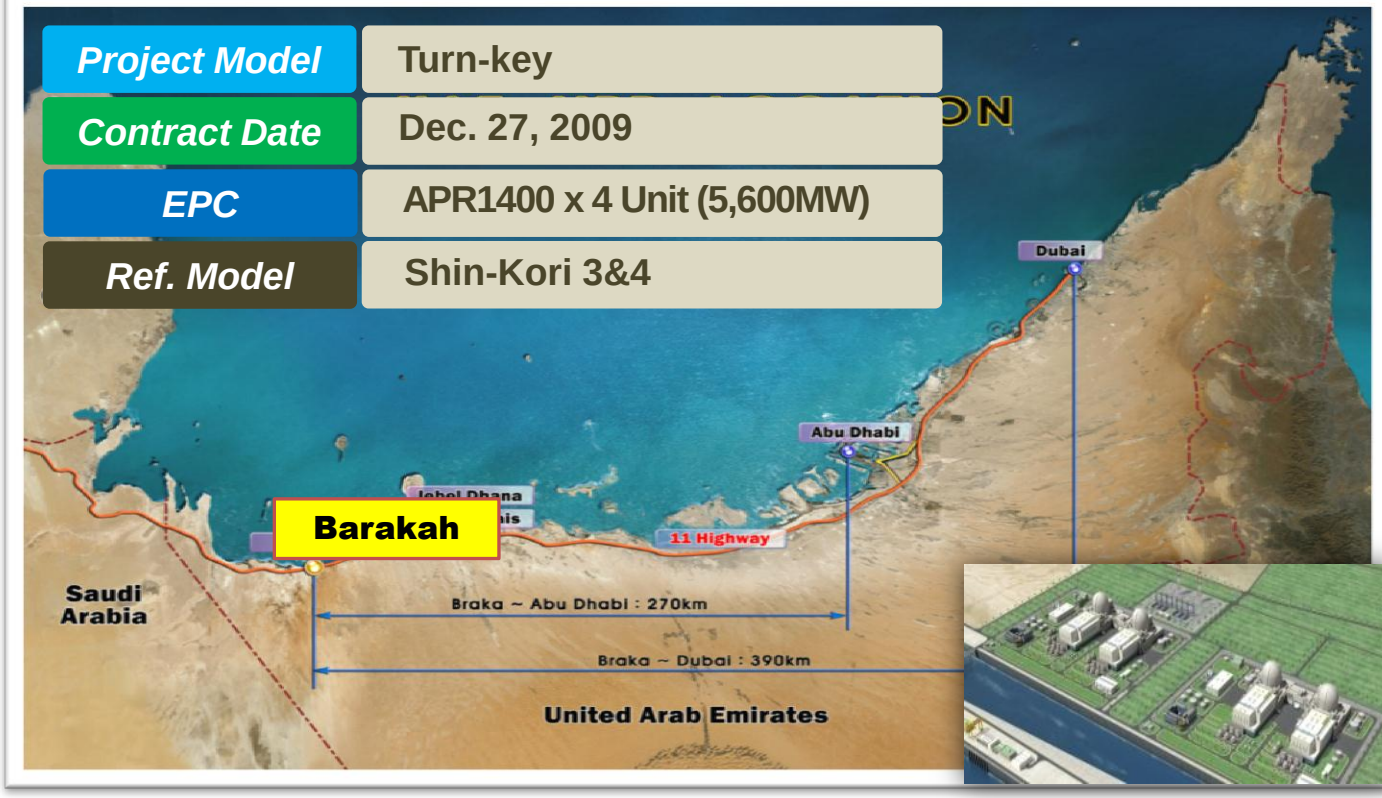
Construction Period

Construction Cost



NPP Construction in the UAE

Project Model	Turn-key
Contract Date	Dec. 27, 2009
EPC	APR1400 x 4 Unit (5,600MW)
Ref. Model	Shin-Kori 3&4



The nuclear options

How to build a nuclear-power plant

The Economist

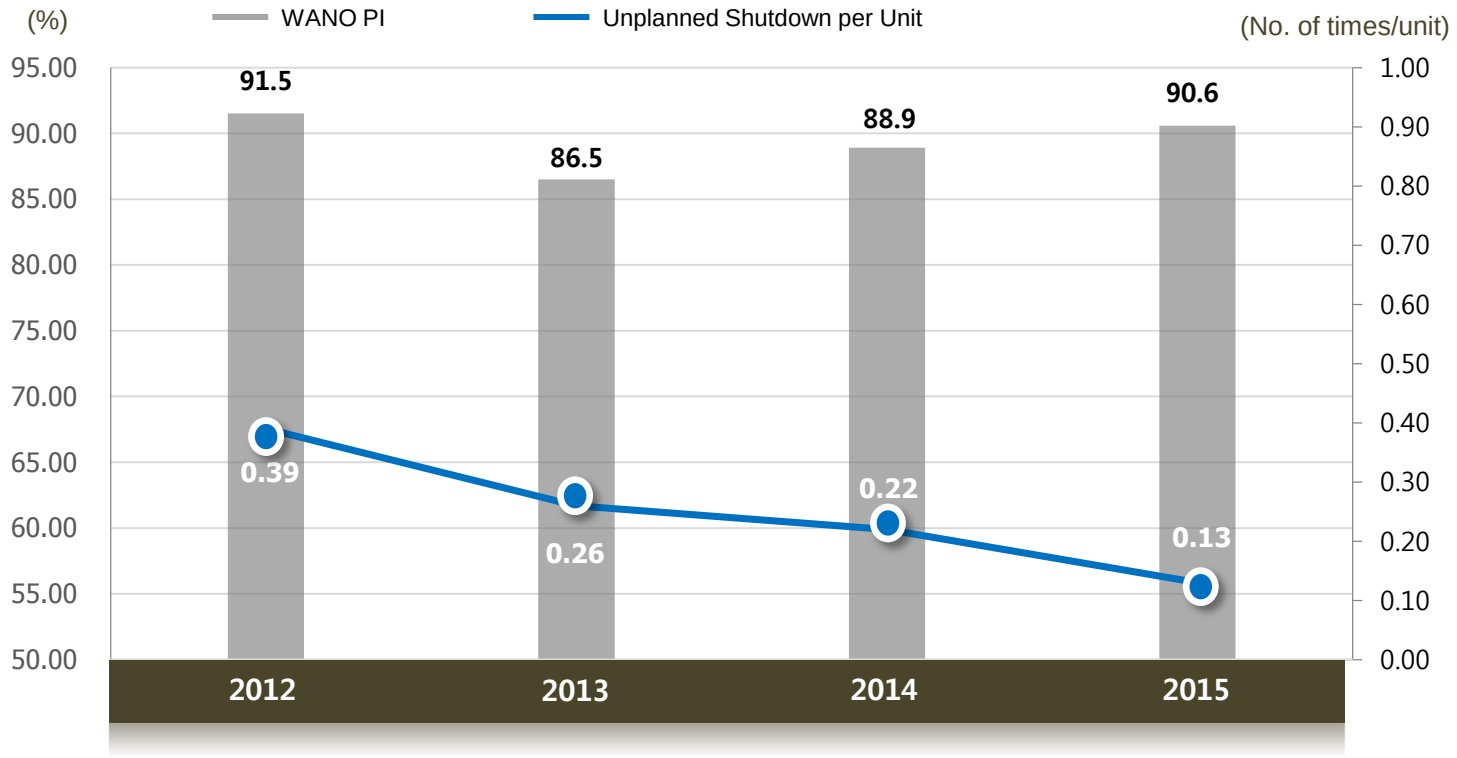
A new crop of developers is challenging the industry leaders

January 28, 2017

THE Barakah nuclear-power plant under construction in Abu Dhabi will never attract the attention that the Burj Khalifa skyscraper in neighbouring Dubai does, but it is an engineering feat nonetheless. It is using three times as much concrete as the world's tallest building, and six times the amount of steel. Remarkably, its first reactor may start producing energy in the first half of this year—on schedule and (its South Korean developers insist) on budget. That would be a towering achievement.

Operating Performance

WANO PI / Unplanned Shutdown



Korea has maintained less than one unplanned shutdown per unit.

Safety Performance

<International Nuclear Event Scale(INES)>

Accident

7 – Major Accident
Chernobyl(1986) Fukushima(2011)

6 – Serious Accident

5 – Accident With Wider Consequences
TMI(1979)

4 – Accident With Local Consequences

Incident

3 – Serious Incident

2 - Incident

1 – Anomaly

0 – Deviation

- The total Rx-year of 25 units has reached 500 years

* Rx-year : Period since 1st grid connection

- Events over grade 3 have NEVER occurred during 500 Rx-year operation

Level	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	Total
'1'	0	1	1	0	1	2	0	0	1	0	2	0	3	4	1	1	17
'2'	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	2
Over '3'	**No occurrence since the first commercial operation in Korea('1978)**																

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3 Nuclear Technology Development

Step-by-Step Approach for Localization

1970's

- Introduction of NPP Turnkey Approach

Foreign Contractors

1980's

- Accumulation of NPP Tech.
- Component Approach
- Localization Planning

Joint Design/Manufacturing
Prime Contractors : Foreign
Sub contractors : Local

1990's, 2000's

- Technology Self-Reliance
- Development of OPR1000
- Development of APR1400

Led by Local Contractors
Prime Contractors : Local
Sub contractors : Foreign

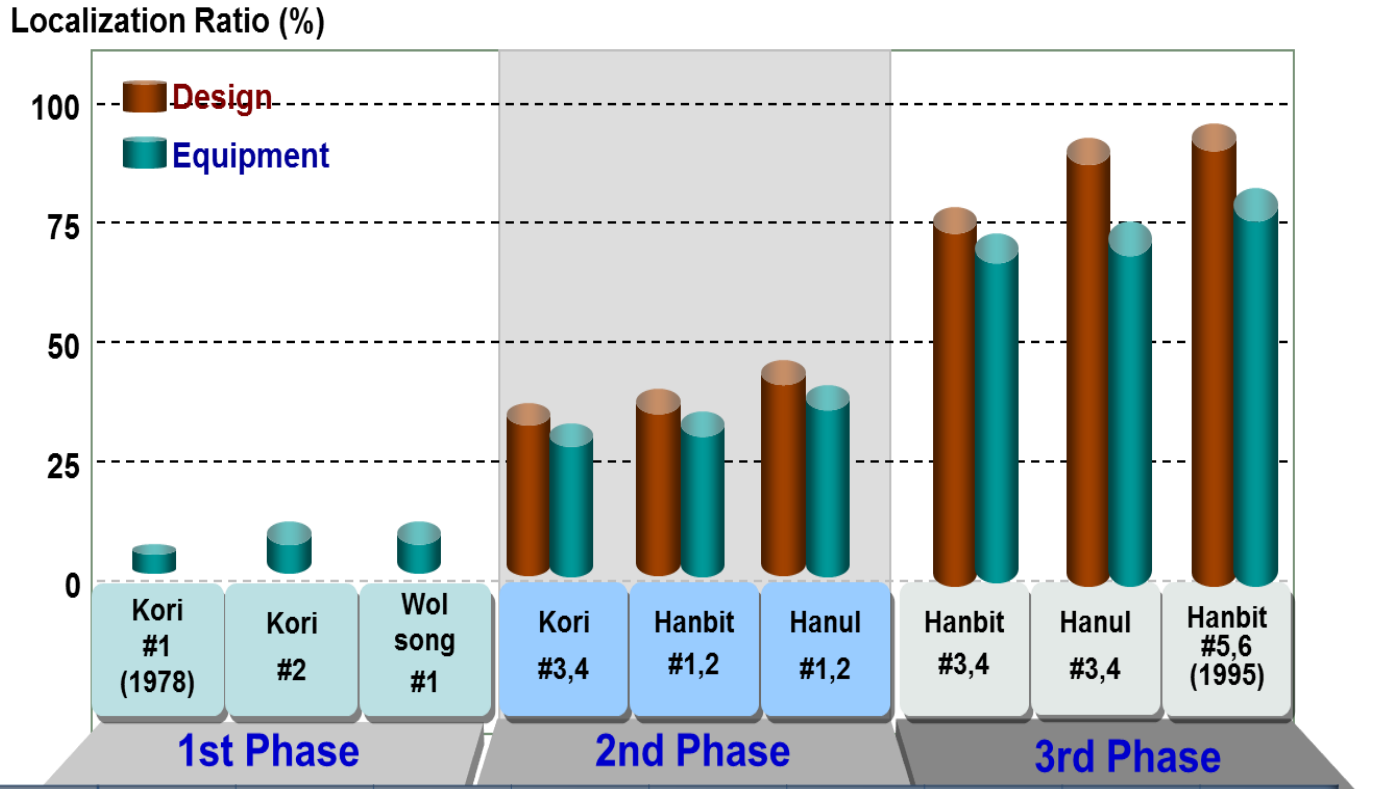
Each step for Localization with clear goal set

1st Step — **Technology Accumulation**
Implemented by Supplier with local participation

2nd Step — **Supplier - Local Joint Implementation**
Implemented by local company with Supplier Participation

3rd Step — **Accomplishment of Technology Self-Reliance**
Implemented by local prime contractor with Supplier assistance as sub-contractors

Localization Result



Design	-	-	-	37%	44%	46%	75%	90%	95%
Equipment	8%	13%	14%	29%	35%	40%	74%	75%	79%

- Recently KHNP completed the development of three key technology that are design code, RCP and MMIS and KHNP will have inherent Design.

Reactor Diversification

APR+

Output	1,500 MWe

US-APR

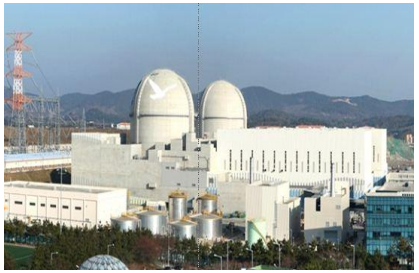
- NRC Design certification in process

EU-APR

Type	PWR
Life	60 Years
Output	1,500 MWe
Seismic	SSE 0.3g

- EUR certification in process

APR1400

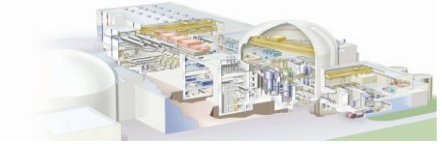


Type	PWR
Life	60 Years
Output	1,400 MWe
Seismic	SSE 0.3g

OPR1000

Type	PWR
Life	40 Years
Output	1,000 MWe
Seismic	SSE 0.2g

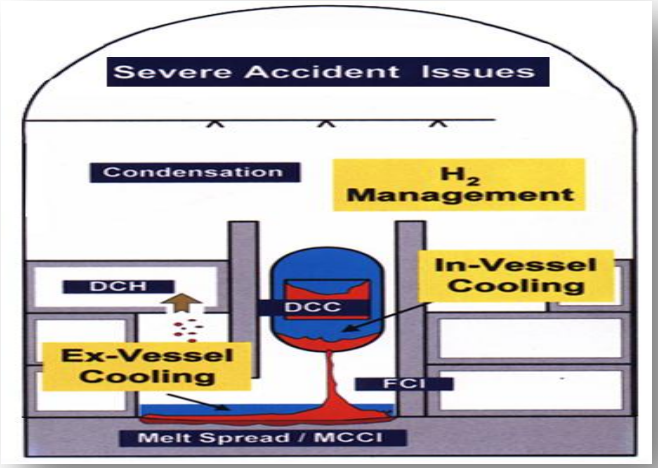
APR1000



Type	PWR
Life	60 Years
Output	1,050 MWe
Seismic	SSE 0.3g

High Technology (APR 1400)

Severe Accident Mitigation



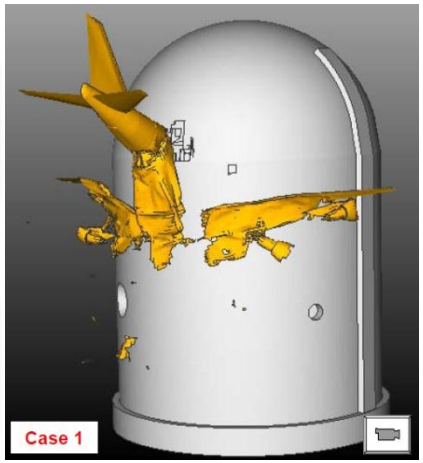
Protect against External hazards

Natural Disasters

Earthquake(0.3g)
Floods(6.5m)
Wind(322km/hr)

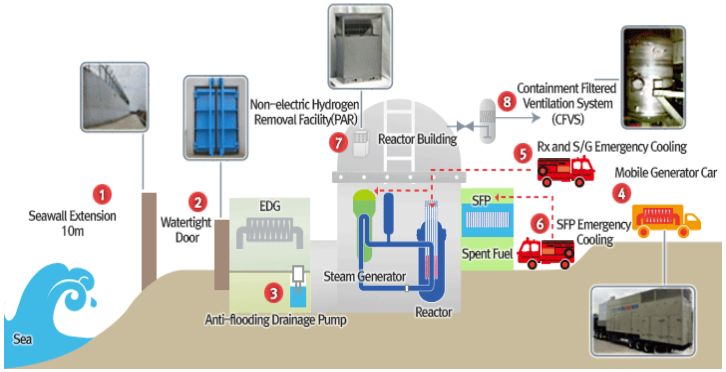
Man-made Hazards

Aircraft crash (Boeing 767-400)
Fire(3-hour resist)



Post-Fukushima Measures

Automatic seismic trip system
Reinforced waterproof functions
Measures against loss of cooling, etc



Design Certification

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC NEWS
Office of Public Affairs, Headquarters
Washington, DC 20555-0001
www.nrc.gov ▪ opa.resource@nrc.gov

No: 15-012 March 4, 2015
CONTACT: Scott Burnell, 301-415-8200

NRC To Begin Full Certification Review of APR1400 Reactor

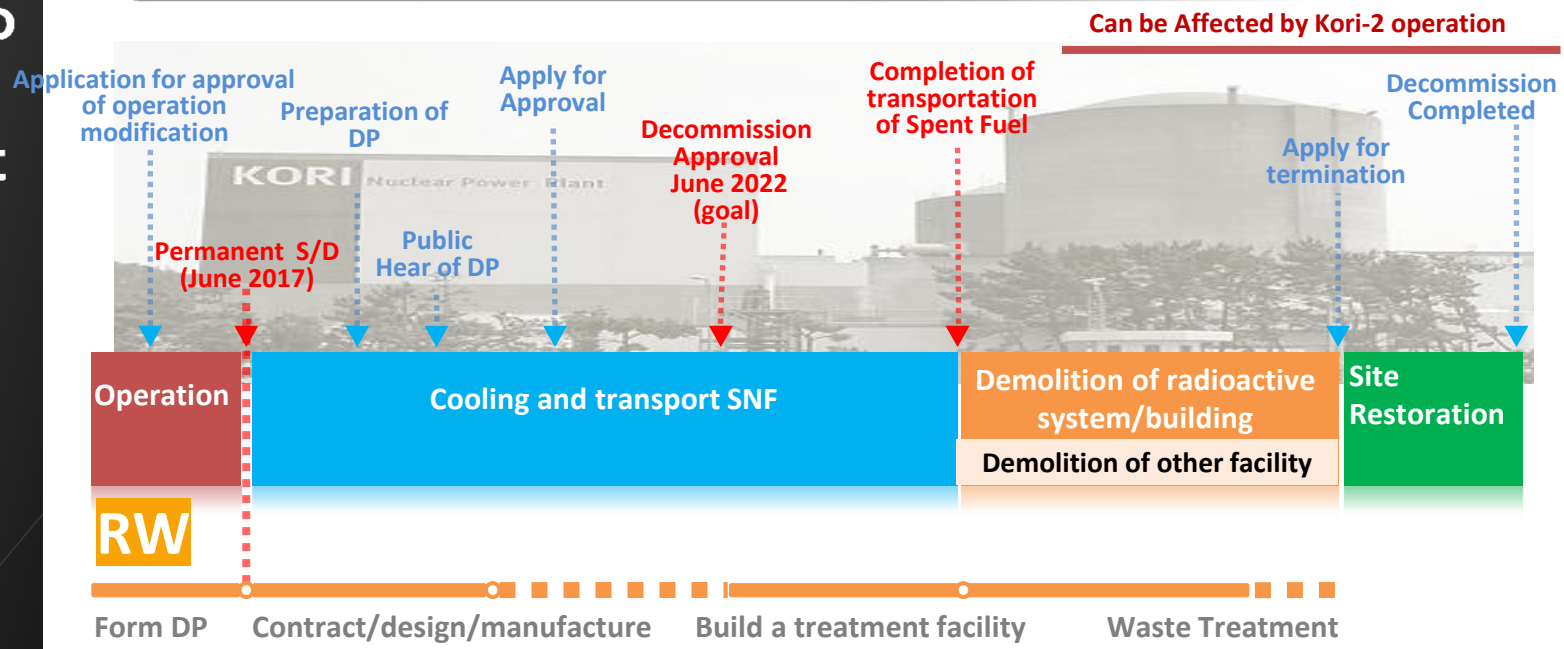
The Nuclear Regulatory Commission has docketed for review Korea Electric Power Corp. and Korea Hydro and Nuclear Power's application to certify the APR1400 reactor design for use in the United States.

The companies submitted their revised application for the design, an approximately 1,400 MWe pressurized-water reactor based on the Korean Optimized Power Reactor 1000, on Dec. 23, 2014. The NRC, after conducting an acceptance check, has concluded the application is complete enough for a full design certification review. The staff will provide a review schedule in the near future.

The NRC's certification process determines whether a reactor design meets the basic U.S. safety requirements. Companies can then reference a certified design in applying for a Combined License to build and operate a reactor in the United States. The NRC's Advisory Committee on Reactor Safeguards provides input on design certification reviews. If issued, certifications are valid for 15 years. The NRC has most recently certified Westinghouse's AP1000 and GE-Hitachi's Economic Simplified Boiling Water Reactor designs.

Decommissioning & SF Management Technology

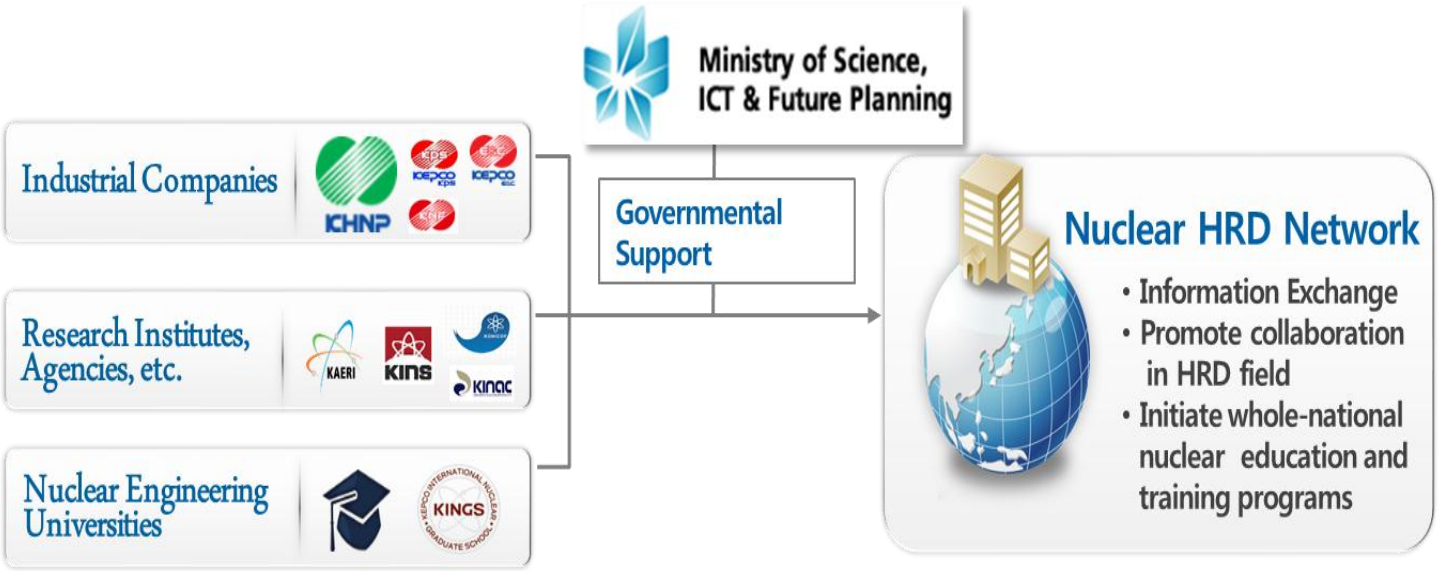
Main Schedule for Kori-1 Decommissioning



Development of Decommissioning Technology

Reactor Vessel and Internals Segmentation
Decontamination of Primary Circuit and Equipment
Preparing Detailed Decommissioning Plan including Process and Methods
Guideline for Site Radiation Survey and Remediation
Development of Radioactive Waste Tracking System

Nuclear HRD Network in Korea



Organization	Education Field
KHNP	Operation and Engineering
KEPCO E&C	Design
KEPCO NF	Nuclear Fuel
KEPCO KPS	Maintenance
KAERI	R&D
KINS	Regulation
KINGS	Master's Degree Graduate

KHNP

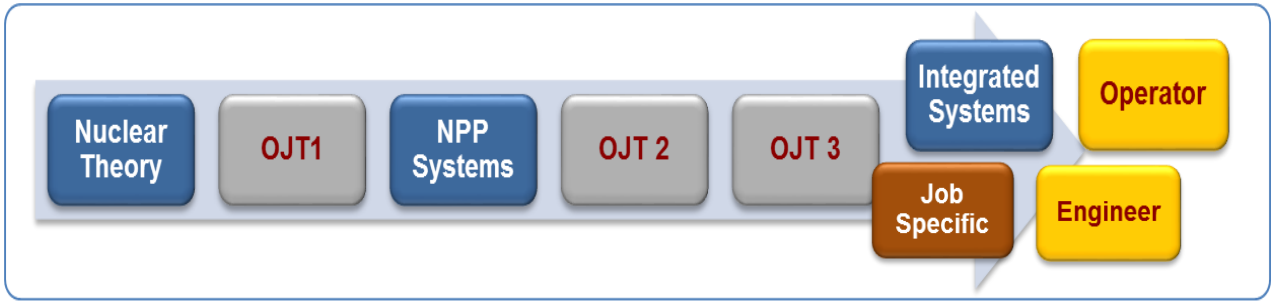
Training for UAE staffs

Successful Barakah NPP Operation Education & Training for UAE Staffs

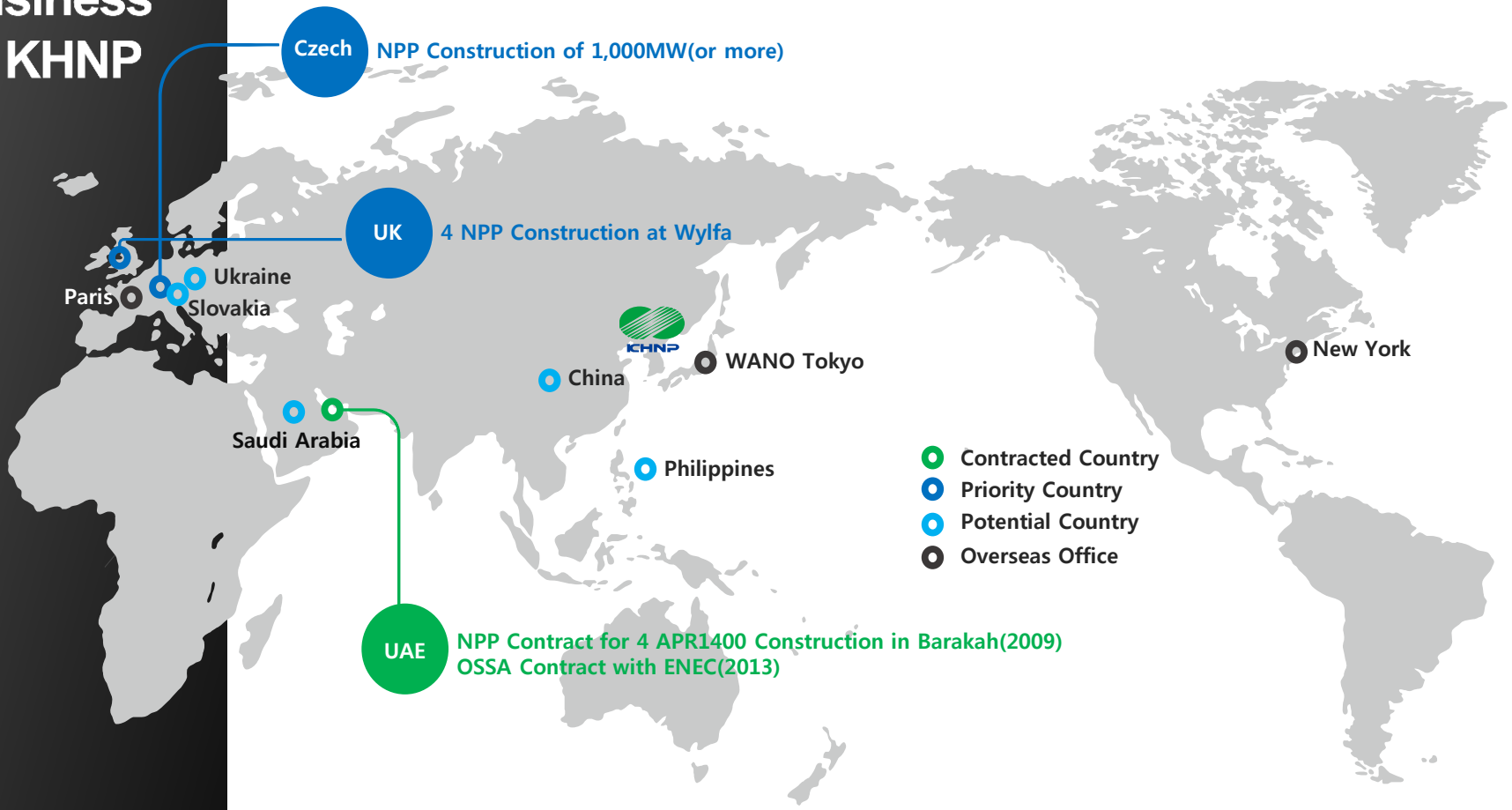
UAE Trainee (792 student)

- BNPP Operators, Engineers, Technicians Training (297 Students)
- UAE Higher Diploma in Nuclear Tech Students (180 Students)
- High School Students Course (202 Students)
- ENEC Staff Plant Familiarization Training (113 Students)

Training Programs



Global Business In KHNP



New NPP Project in Philippines

- **2009 F/S for Bataan performed by KHNP**
- **KHNP's Kori #2 is sister plant to Bataan**
  - Kori #2 have been excellent performance without any incident(Based on INES Level)
  - Immediate appliance of O&M experience over 30 years to Bataan
  - Highly skillful workforce from Kori #2 can be immediately dispatched to Bataan (RO/SRO 264)
  - Utilizing advanced Kori #2 training infrastructure
  - Strong Supply Chain & Backup equip. of Kori#2
  - Evaluating the possibility to use equipment from permanently shut down Kori #1
  - Abundant Power Uprating Experience
- **Integrated New NPP Project Service from A to Z**

ANGRA 1, Brazil

KRSKO, Slovenia

Bataan, philippines

KORI 2, South Korea

THINK SAFETY

Thank You