SIEW RSIS Roundtable on Nuclear Safety and Security Culture in East Asia, 2017.10.27

KINS is a Cornerstone for a Safe Korea

Nuclear Safety and Security Culture

- South Korea perspective

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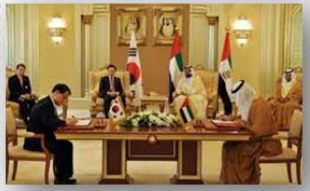
History of Nuclear Energy Development Program

1960s	1970s	1980s	1990s	2000s	2010~
Preparation for Nuclear Energy	Introduction of Nuclear Power	Promoting Localization	Technology Self-reliance	Advanced Tech. Development	Export of APR1400
					
Joining IAEA Research Reactor	Construction of Kori #1	Establish Localization Plan	OPR1000, Hanaro Development	APR1400 Development	APR1400 Export
	Turnkey Contract	Component Approach	Technology Self-Reliance	APR-1400 Design Project	APR + Design Project
NEPIO	Government & KAERI(TSO)	Government & NSC(TSO)	Government & KINS(RSO)		NSSC('11)

Role of Nuclear Safety Regulation

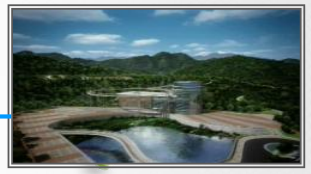
Current Status of Nuclear Installations in Korea

Nuclear Power Plants

- In Operation : 24 Units
- Under Construction : 5 Units

HanUl
(Ulchin)

Wolsong



Gyeongju

Low & Intermediate-Level Waste
Disposal Facility

Hanbit
(Younggwang)

Seoul

Daejeon

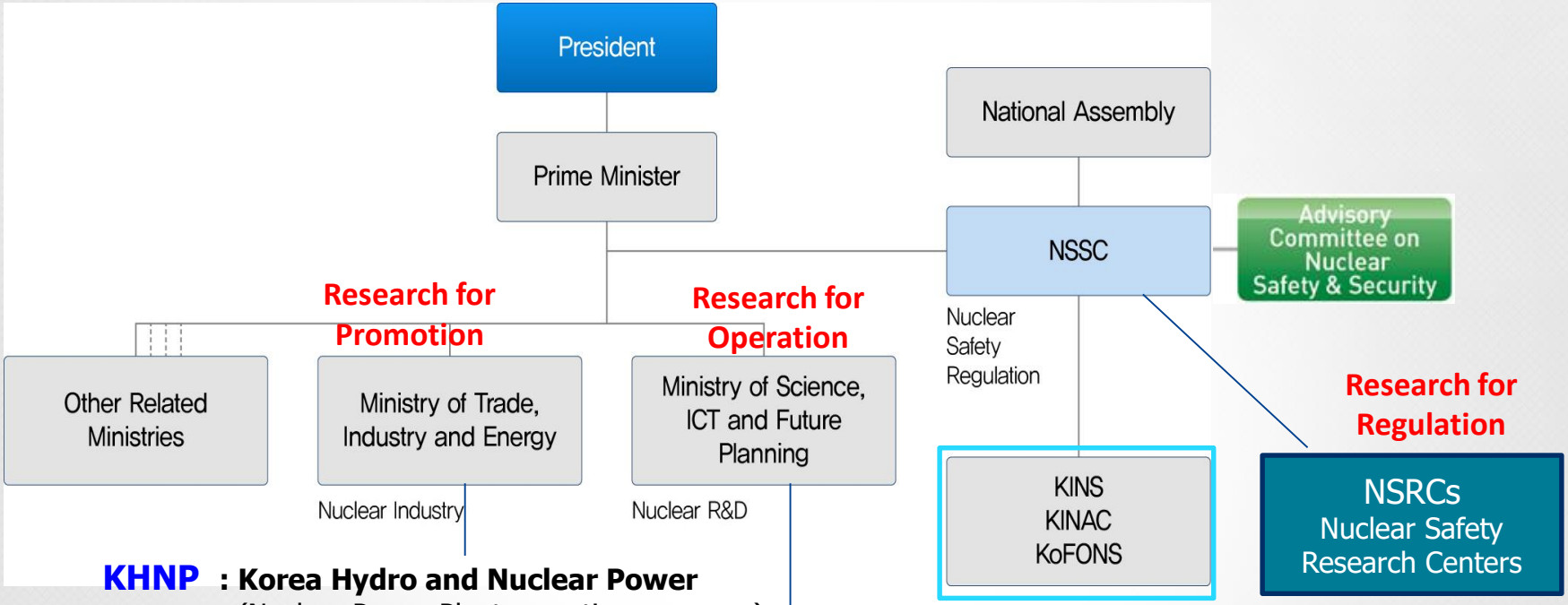
Kori

HANARO

Reactors for Research and Education

HANARO : 30MW research reactor
AGN-201K : 10W reactor for education
Kijang Research reactor : 20MWt (CP applied in Nov. 2014)

Nuclear Energy Organizations



KHNP : **Korea Hydro and Nuclear Power**
(Nuclear Power Plant operating company)

KAERI : **Korea Atomic Energy Research Institute**
(Nuclear Research and Development)
Research Reactor operation

NSSC : **Nuclear Safety and Security Commission**
(Regulatory Body)

KINS : **Korea Institute of Nuclear Safety**
(Technical Expert Organization, Safety side)

KINAC : **Korea Institute of Nuclear Nonproliferation And Control** (Security side)

KoFoNS : **Korea Foundation of Nuclear Safety**
(Safety Research management)

KINS overview

- KINS is a regulatory expert organization established in 1990
- KINS protects the public health and environment from potential radiation hazards under 『Korea Institute of Nuclear Safety Act』(1989)
  - The purpose of KINS Act is to establish the KINS as a dedicated technical expert organization for nuclear safety regulation

NSSC (2011~)

Policy setting, authorization, enforcement actions, and administration

Government Official

+

KINS (1990~)

Technical decision through review and assessments, inspections and R&D

KINS focuses on Technical Aspects

Roles of Regulatory Organizations

- The Nuclear Safety and Security Commission (NSSC, 2011~)
  - Regulatory authority of the Korean Government
  - 3S (Safety, Security, Safeguard)
  - Rulemaking and enforcement on nuclear facilities and activities to ensure safety
  - Developing and implementing nuclear regulatory policies
- Korea Institute of Nuclear Safety (KINS, 1990~)
  - Regulatory expert organization, Safety side
  - Carry out functions concerning nuclear safety review and inspection, developing technical standards and guidelines
  - Promotion of Safety Culture
- Korea Institute of Nuclear Nonproliferation and Control (KINAC, 2006~)
  - Regulatory expert organization, Security side
  - Execution of safeguards, export and import control regarding nuclear facilities and materials
  - Promotion of Security Culture

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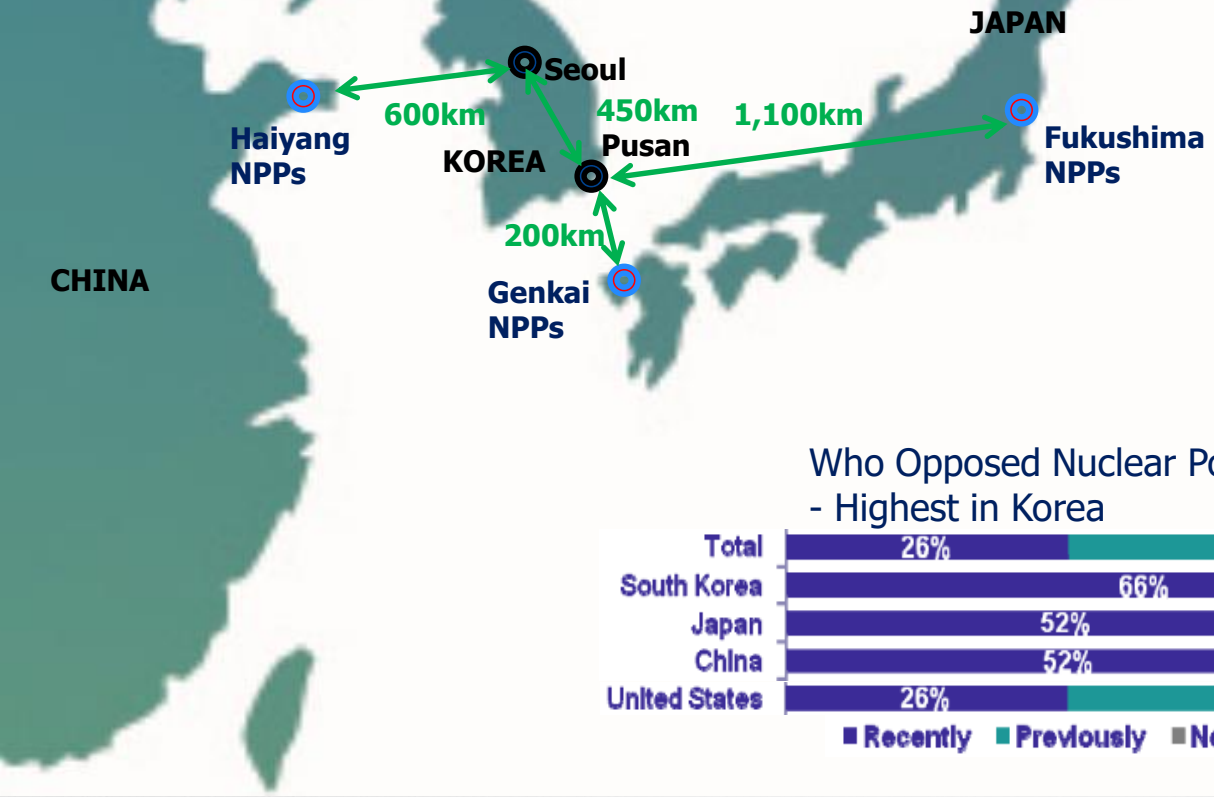
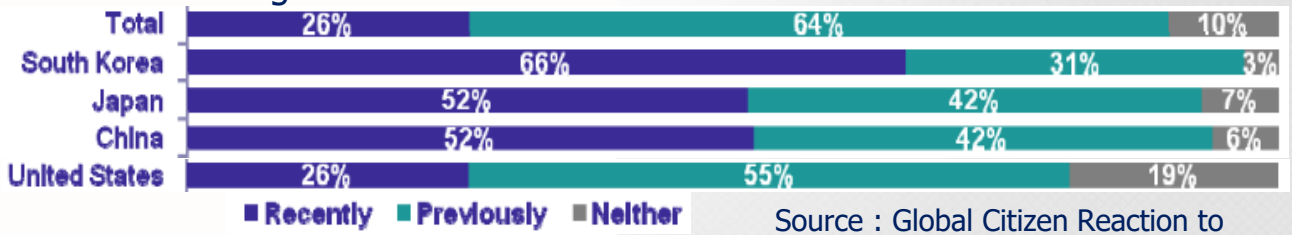
Impact of Fukushima Accident in 2011

- Korea was greatly influenced by the Fukushima accident
  - The public were very sensitive to radiation risk from the accident as the closest neighbor country



Scale	Perception on Nuclear of Residential People (Before / After)
Very Safe	2.6 / 0.4
Safe	19.4 / 2.8
Neutral	24.8 / 7.2
Risky	28.8 / 43.2
Very Risky	24.4 / 46.4

Who Opposed Nuclear Power Influenced by events In Japan
- Highest in Korea



Source : Global Citizen Reaction to Fukushima disaster (Ipsos survey 2011)

Safety Culture issues in 2012~2013

Safety Culture issues raised in Nuclear industry (2012~2013)

I. **The Cover-up of Station Blackout(SBO) incident at Kori Unit 1 in 2012 served as an opportunity to remind the importance of safety culture.**

II. **The Use of Falsified quality documents revealed in 2012 and 2013.**

- Regulatory body conducted complete enumeration forgery investigation for domestic supplied items.
- Overseas testing entities are under examination since Feb. 2014

Regulatory oversight scope is widened to cover human and organizational issues

I. **Regulatory scope is widened to cover overall nuclear supply chain.**

- **"vendor inspection", "reporting of non-compliance**", and **"contract notifying"**
- Equipment & Material Tracking system for all safety-related items

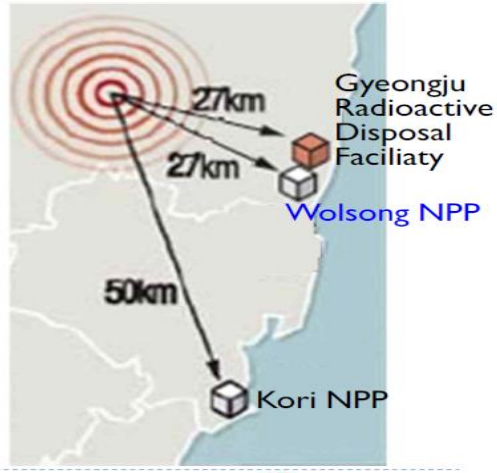
II. **National mid-term plan to foster safety culture**

- Research project to build-up Safety Culture oversight infrastructure (2013-2016)
  - Special safety culture inspection for NPPs including KHNP head office
- Periodic Safety Review includes licensee's management system and safety culture.

Gyeongju earthquake in September 2016

❑ **Earthquake in Gyeongju with magnitude of M_L 5.8 took place on 12 September 2016**

- ❖ Observed the strongest one ever instrumentally recorded in Korean Peninsula.
- ❖ The epicenter located approximately at a depth of 15 km in an area 27 km away from the Wolsong NPP site
- ❖ Presently recorded over 600 aftershocks



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Nuclear Safety and Security Commission

- ❖ Wolsong #1~4 were manually shutdown in accordance to the seismic response manual and resume operation (12/2016) after a safety check-up

❑ **Post-Gyeongju Earthquake Safety Actions (Dec. 2016)**

- ❖ Detailed geological/seismological research on the epicenter area

- **Growing public fear for the seismic hazard after the earthquake**
- High public concern on license renewal of old NPP like Kori 1 and wolsong 1
- Public distrust on multi-unit site safety (Kori site have 8 NPP unit, and will be 10)
- Active anti-nuclear movement

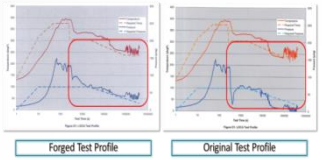
Issues, Countermeasures and Changes in Public Concerns

Public concern

Comprehensive Assessment('11.5)
- 50 Action Items

NSSC establishment ('11.10)

원자력안전위원회 NUCLEAR SAFETY AND SECURITY COMMISSION



Falsification of QVDs('12.12, '13.3)

Stress Test ('13.4~)

Corruption investigation,
Cyberattack threat,
Worker's death, Rx Trips..

Earthquake ('16.9)

?

SBO Concealment('12.2)

Fukushima Accident('11.3)

- **Public perception on nuclear depends largest on 'Safety'**
  - ✓ 'safety' : 55.3% (1st importance)
  - ✓ 'necessity' : 30.8% (2nd largest)

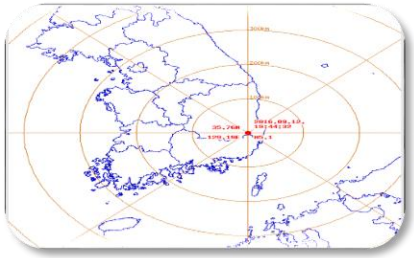
Public perception survey on nuclear
2016. Korea Nuclear Energy Agency

Time

Current status of Korea (in brief)

Concern on Earthquake

Concern on earthquake and seismic safety of NPP



Movie 'Pandora' ('16.12) and public worries on Emergency Preparedness

Decommissioning, Spent nuclear Fuel

Permanent shutdown of Kori-1, Decommissioning

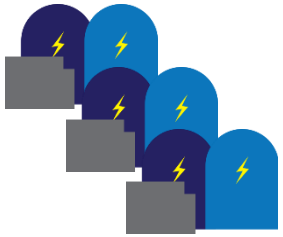
Social conflict w.r.t Disposal of Spent Fuel

Reveal of KAERI unauthorized radioactive waste disposal('17.2)

New Issues

Assessment of multi-unit site safety, PSA level-3

- max. 10 units at Kori site



Administrative litigation on Wolsong-1 lifetime expansion

New government's commitment on Nuclear

- Move towards Nuclear-free era
  - Establishment of Roadmap for nuclear phase-out
  - Halt plans to build new NPPs
  - Stop construction work of Shinkori-5,6

    - construction resumed after deliberative polling(`17.10.20)
  - Prohibit extension of the lifespan of existing plants
  - Permanent shutdown of Wolsong-1 (second-oldest reactor, currently operating)
- Strengthen safety level of NPP
  - Empowerment to regulatory organization
  - Application of the latest safety standard to operating NPPs
  - Higher level of seismic design criteria
  - Prohibit outsourcing of safety-related works
- Public participation in regulator's decision making

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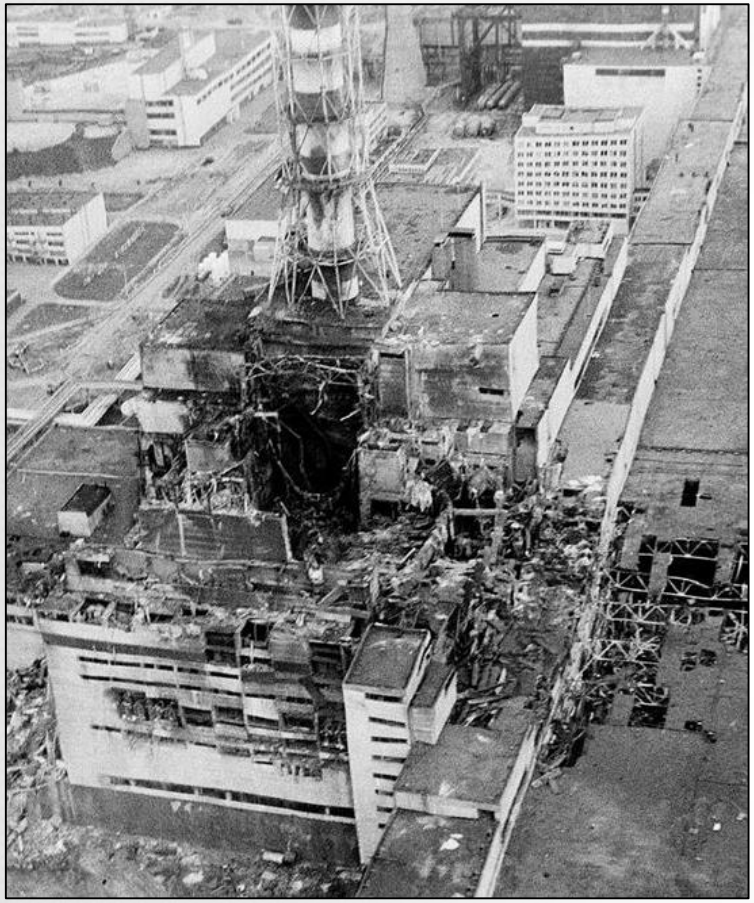
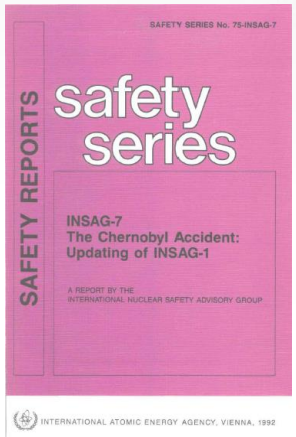
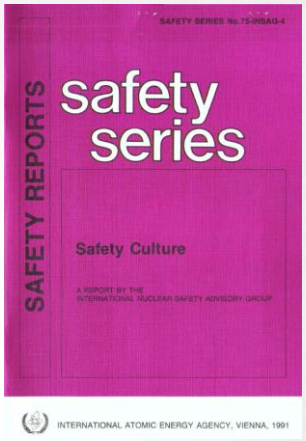
Safety Culture since 1986



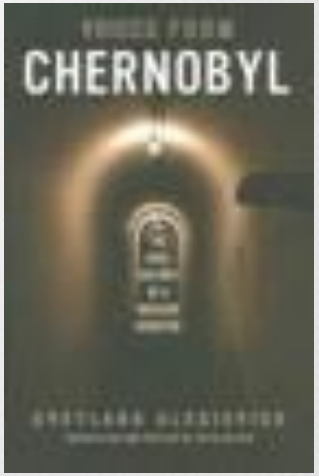
Chernobyl 4 (1986)





Safety Culture
- IAEA SS No.75-INSAG-4(1991)

Chernobyl Accident
- IAEA SS No.75-INSAG-1(1986)
- IAEA SS No.75-INSAG-7(1992)

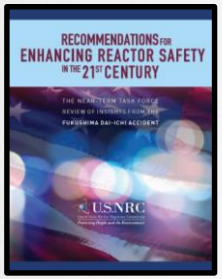


Voices from Chernobyl (2005)
체르노빌의 목소리 (2015)

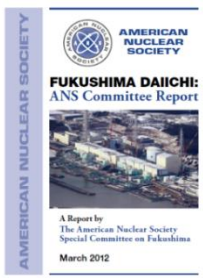
* INSAG : International Nuclear Safety Group of IAEA

Why and how Fukushima Accident happened?

MIT, '11.5

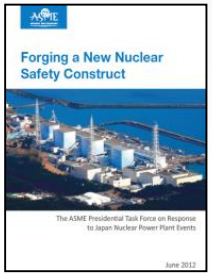


US NRC, '11.7



ANS, '12.3

Carnegie E, '12.3

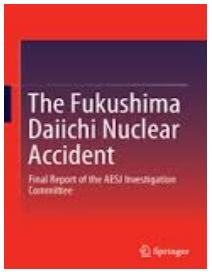


ASME, '12.6

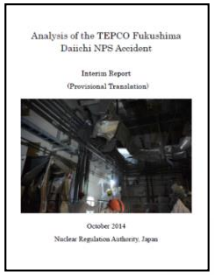
Investigation Committee, '11.10

National Diet (NAIIC), '12.7.5

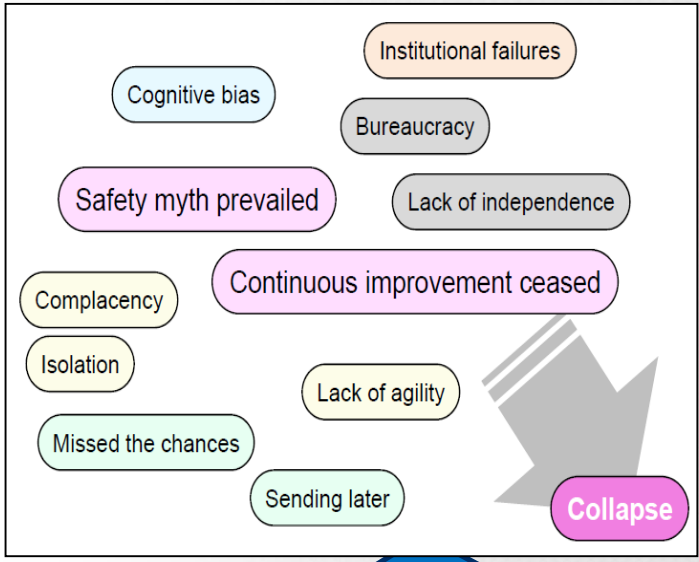
ICANPS, '12.7.23

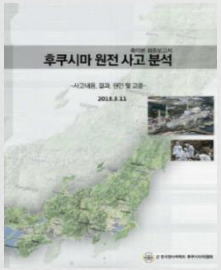


JNS, '14.3

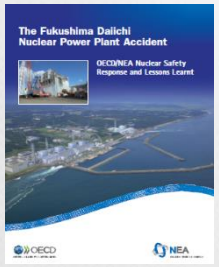


NRA, '14.10



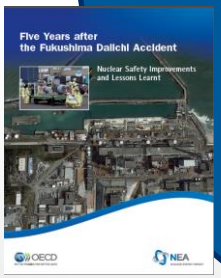


KNS, '13.3



OECD/NEA, '13.9

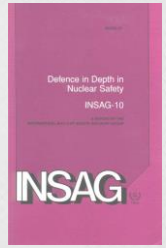
IAEA, '15.8



OECD/NEA, '16.3

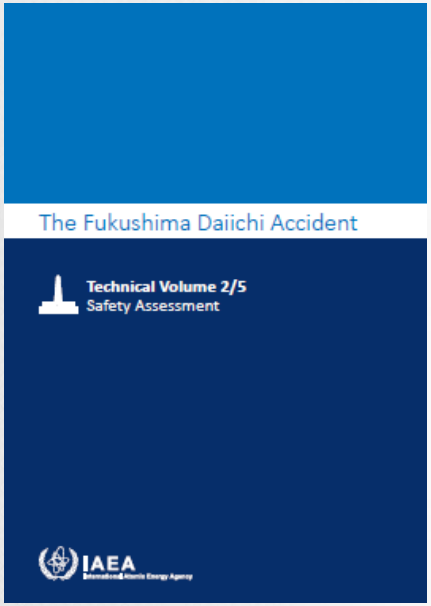
Defence in Depth

- The concept of defence in depth is fundamental to the safety of nuclear installations
- Multiple levels of protection is the central feature of DiD



Defence in Depth in Nuclear Safety
- IAEA SS No.75-INSAG-10(1996)

IAEA Fukushima report says..



The Fukushima Daiichi Accident – Technical Volume 2. 'Safety Assessment' IAEA, (2015.8)

- While it is important to continue to seek further enhancement of international safety standards and to propose technical improvements, **these are not sufficient** by themselves **to ensure adequate implementation of design safety principles such as defence in depth**
- ….
- The fundamental lesson is that while there may be rigorous and comprehensive safety standards and other tools in place to deliver high levels of safety, it is ultimately important to have a nuclear safety system that ensures that the **relevant institutions diligently and effectively apply those standards and tools**, taking into account human and organizational factors.
- …..
- A systemic approach to safety needs to consider the **interactions between human, organizational and technical factors**. This approach needs to be taken through the entire life cycle of nuclear installations.

Lessons from the Past

NSSC (2011)

TMI(1979) | Chernobyl(1986) | Fukushima(2011) | Issues in Korea

The defence in depth(DiD) concept remains valid, but implementation needs to be strengthened.

Technical	Human/Organizational	Institutional
Lessons learned from Fukushima	Fukushima lessons + Issues in Korea	Fukushima lessons + Issues in Korea
Reevaluate External Event	Safety Culture, Quality Assurance	Independence, Peer Reviews, 3C

* **3C** : Communication, Cooperation and Collaboration

Changes in the role of regulator regarding SC

- Issues in Korea
  - Station Black Out Concealment event in Kori unit 1 (Feb. 2012)
    - Plant manager's decision not to report it resulted in subsequent violations.
    - After a month, revealed by an outside person and then publicized.
  - The Use of Falsified quality documents was revealed by whistleblower's tip (Nov. 2012, April. 2013).

- Root Cause
  - Moral hazards and complacency encouraged by good performance of NPPs
  - Lack of questioning attitude and problem in raising safety concerns

- Korean regulator concluded that safety culture aspects were not properly managed by licensee and therefore minimum requirements should be imposed on.

- Concealment shows the importance of Leadership and Management, and Safety Culture.
  - Consideration should be given to the whole aspects of the organization's safety culture.

Safety Culture Activities Overview

- KINS launched research project in 2013 aiming development of regulatory infrastructure and implementation system for oversight of nuclear operator's safety culture.

  - Regulatory infrastructure includes oversight model, methodology, inspection guides, education and training program for inspectors, and legal and institutional elements on which oversight activities should be based.

- Safety Culture Inspections are conducted on KHNP during 2013~2015

  - Major Findings and Areas for Improvement are identified

- Safety culture promotion activities are conducted including;
  - Seminars and workshops to licensees and lectures to license holders
  - Information exchange meetings with safety culture officers of licensee
  - Top-Management safety culture dialogue
  - Annual regulatory information conference includes safety culture session

- Active international cooperation including;
  - Information Exchange Meeting with US NRC (2014~2016)
  - Bilateral Technical Meeting with Foreign regulators - CNSC(2014), ONR(2014), STUK(2016), ENSI(2017) focused on Safety Culture

Safety Culture Oversight Model

The Safety Culture Oversight Model (SCOM) of KINS is developed to focus on the organizational capabilities to maintain, improve and recover the integrity of key elements which play a major role in implementing the concept of Defence in Depth.

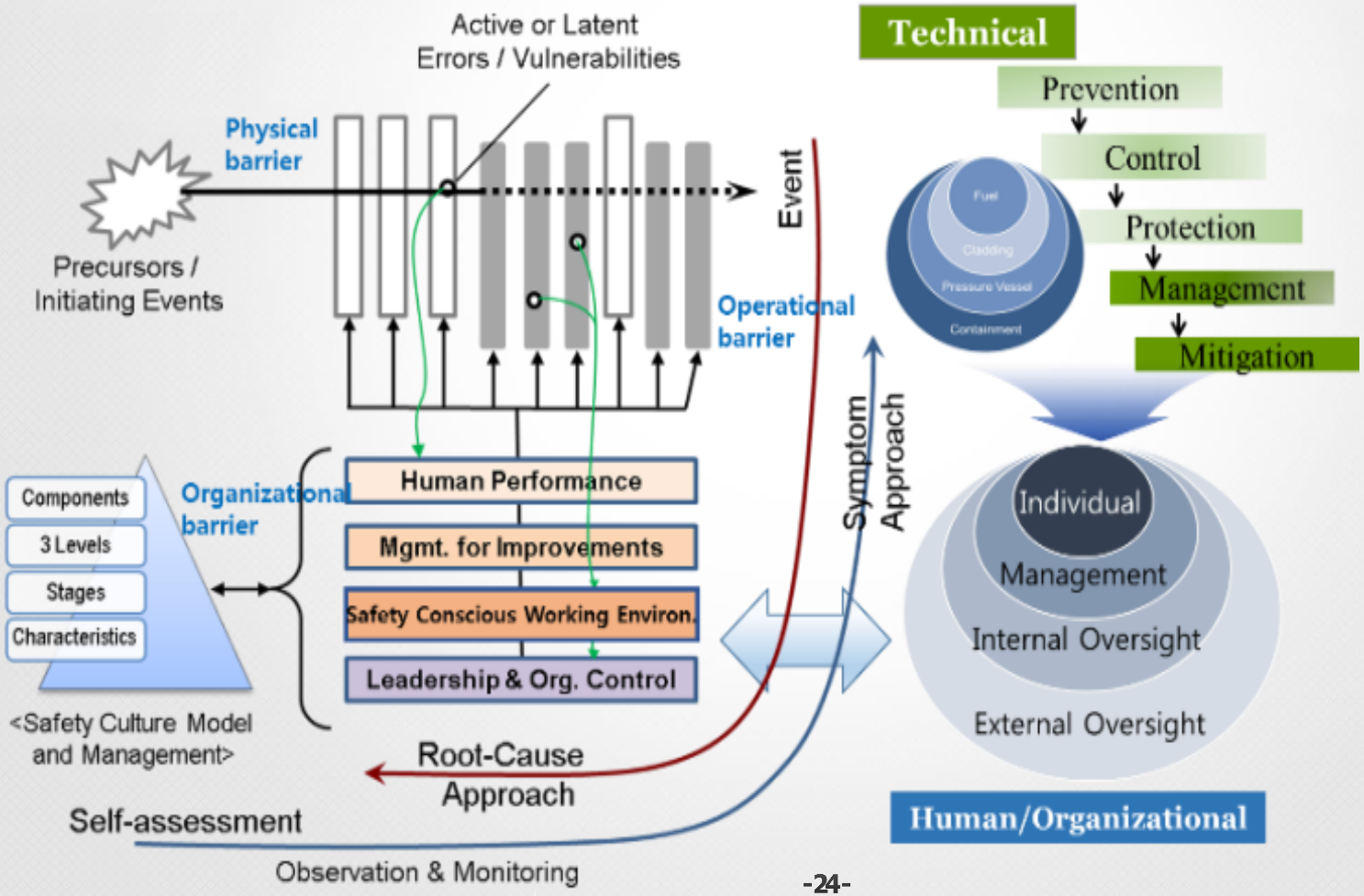


Fig. Concept and Approach for SC oversight model development

Safety Culture initiatives inside KINS

- Background
  - Lessons from Fukushima (IAEA Final Report on Fukushima Accident)
  - Joint workshop titled "Challenges and Enhancements to Safety Culture of the Regulatory Body" in June, 2015
  - OECD/NEA report "The Safety Culture of an Effective Nuclear Regulatory Body" in 2016
  - IAEA GSR Part 2, June 2016 (Leadership and Management for Safety)
- Development of draft Safety Culture Principles and Attributes for KINS
  - KINS staff meets licensees so frequently that its SC should be maintained and developed.
  - Leadership for Safety, Ethics and Independence, Communication and Cooperation, Questioning Attitudes and Decision Making, Expertise and Continuous Improvement
- Development of 'Safety Culture Management Procedure' in 2016
- Ongoing and Planned Activities
  - Implementation of each SC principle and periodic evaluation
  - Finalization of SC principles in 2017
  - Expanded use of the principles and attributes

National commitment on Safety Culture

- In 1994, the Korean government declared "**Nuclear Safety Policy Statement**"
  - (Chapter 2) Safety Culture
  - (Chapter 3) Regulatory Principles (5)

- In 2001, the Korean government declared "**Nuclear Safety Charter**"
  - Top level philosophy and principles for nuclear people

Recognizing that the peaceful use of nuclear energy contributes to national development and improvement of the quality of public's life, and confirming that protection of the people and preservation of the environment through safe control of nuclear energy have first and foremo st priority, we pledge ourselves:

1. To maintain the highest standards of safety in the use of nuclear energy;
2. To disclose information regarding nuclear safety promptly and transparently;
3. To reflect public opinion in formulating nuclear safety policies;
4. To assure independence and fairness in nuclear safety regulation;
5. To strengthen research and development of nuclear safety technologies;
6. To sincerely abide by national laws and international agreements on nuclear safety;
7. To continuously complement and improve the nuclear safety-related legal system;
8. To promote nuclear safety culture and incorporate it in our workplace.

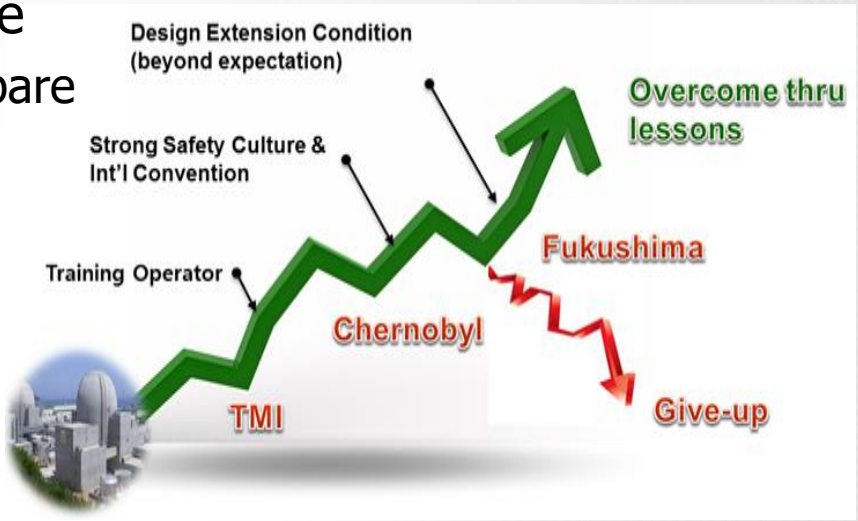
Contents

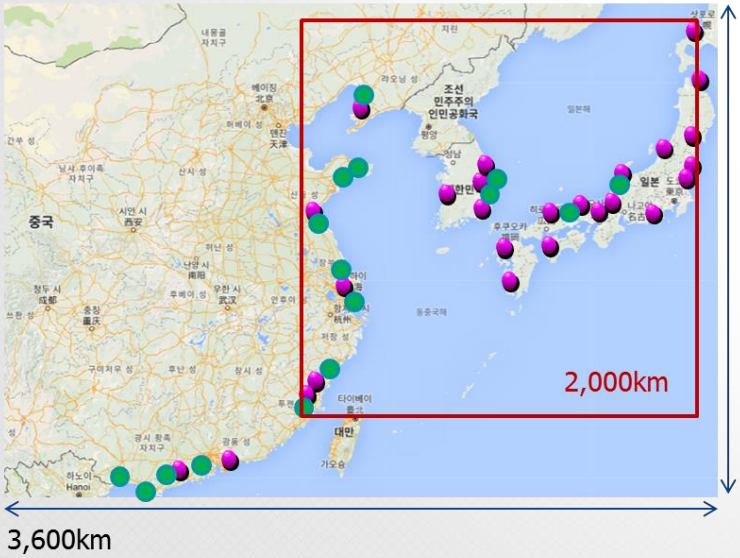
Challenges

- Public perception of Nuclear Safety is key
  - Even though there wasn't any nuclear accident in Korea for last 40 years, public think nuclear power is not safe
- How to keep Nuclear Competency when the government calls for nuclear-free era
  - NPPs under construction are to be operated even after 2080s
- Export of NPPs
  - Multicultural job environment and its effect on safety, security, and culture change
  - National nuclear competency
- Nuclear Safety – Security Interface
  - NSSC's regulation of nuclear security is supported by KINAC and security culture as well. Safety and safety culture by KINS
  - Operational safety and security interface and cultural harmonization are important works to be done.

Moving forward

- Nuclear Safety is becoming Global Issue
  - Collective Intelligence is needed to prepare for the 'next'.
  - 3Is (Interdisciplinary, Intelligent tech., Integration) approach to manage the unexpected.





- Cooperation is Essential
  - TRM(Top Regulators' Meeting) and TRM+ for nuclear safety in Northeast Asia
  - Interdisciplinary research needed
    - Engineering + Social Science
    - Management leadership, etc

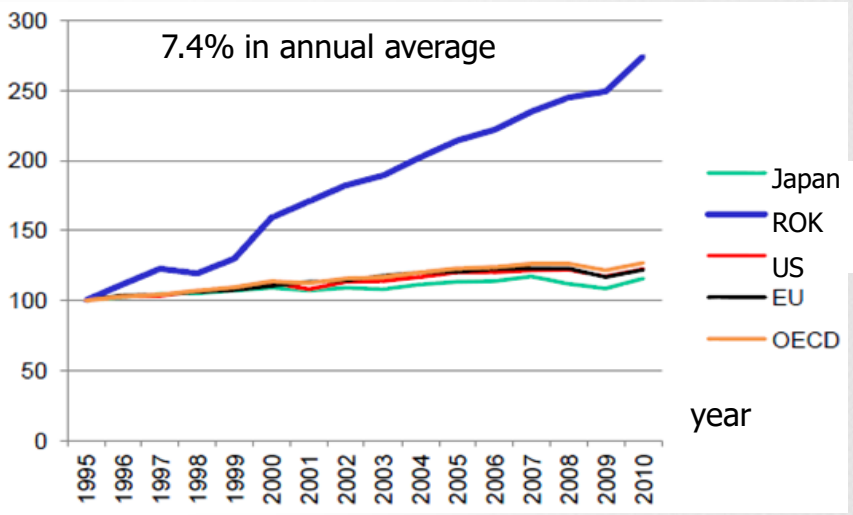
THANK YOU

KINS
KOREA INSTITUTE OF NUCLEAR SAFETY

Energy Environment of Korea

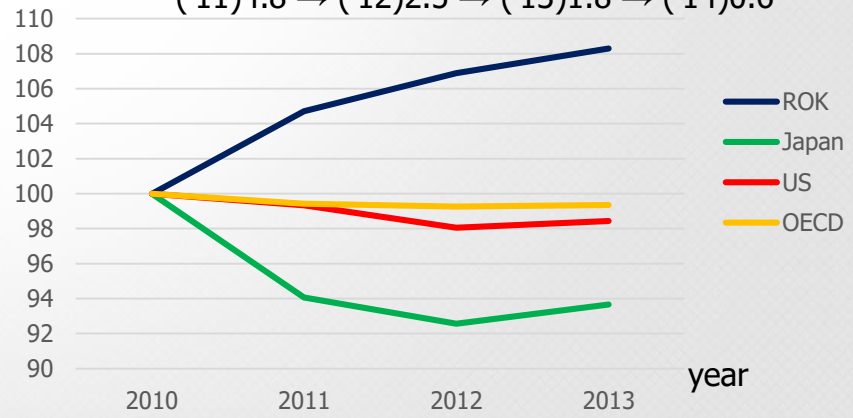
- Industry's heavy reliance on Electricity
  - Steel, shipbuilding, IT systems, …
- Increase in Electricity demand
  - Highest among OECD countries (1995-2010)
  - Effects of low electricity charge, high electrification
  - Decreasing trend
  - 7.4%('95~'10) → 2.2% ('11~'14)
- Growing CO_2 emission
  - World 2nd largest increasing rate
  - 296(1990) →668(2012) million tons
  - 37% Reduction goal (~2030)
  - compared with emission forecast 851

[Energy demand comparison]



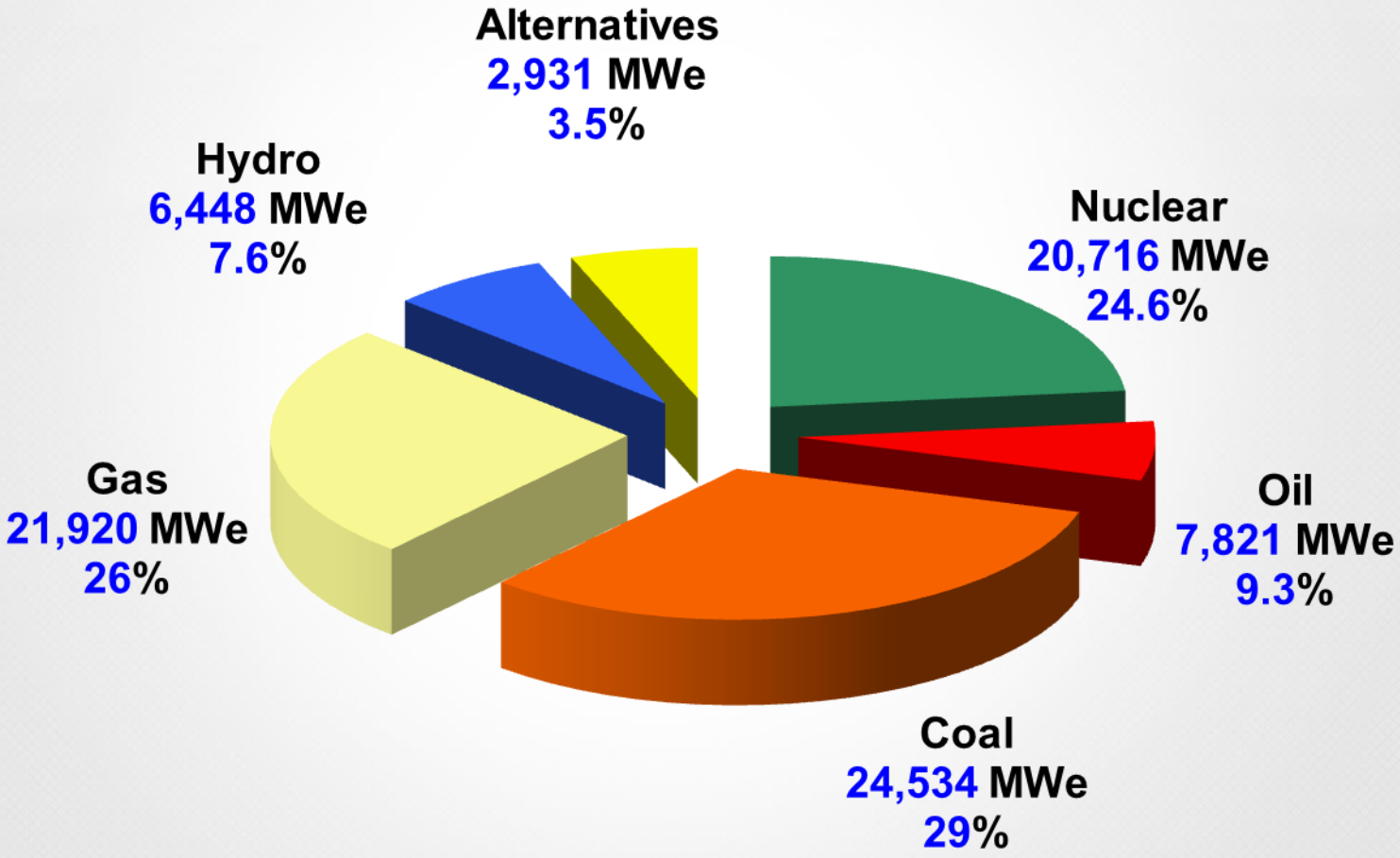
Energy demand increase rate(%) :

('11)4.8 → ('12)2.5 → ('13)1.8 → ('14)0.6



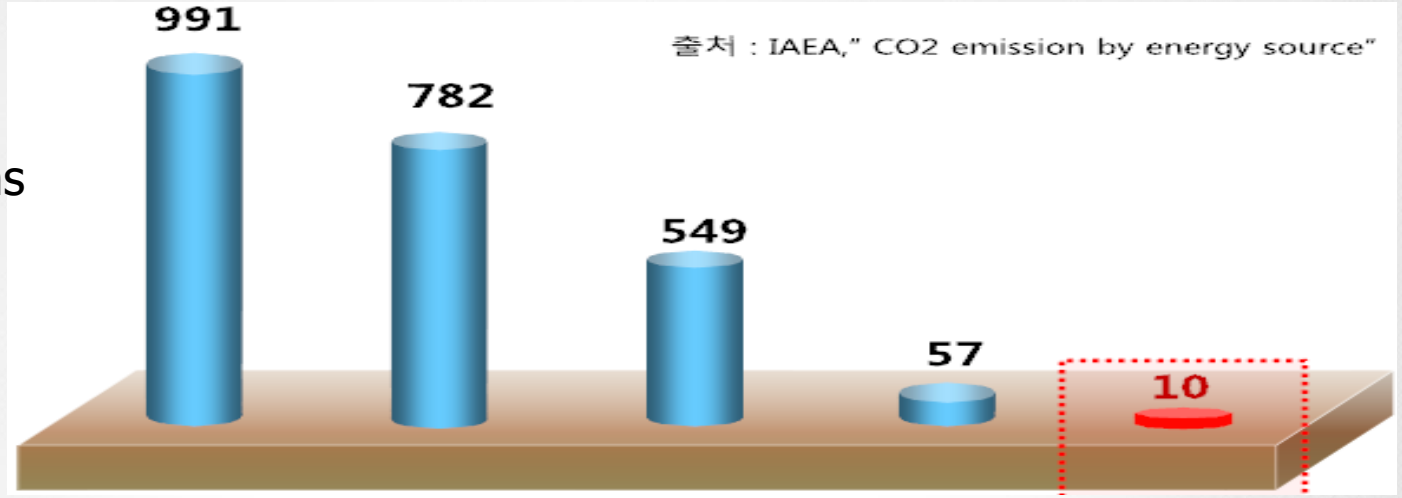
Overview of Nuclear Power Program (2013)

- Total Installed Capacity (As of June 2013) : 84,371 MWe



Energy Sources in Korea

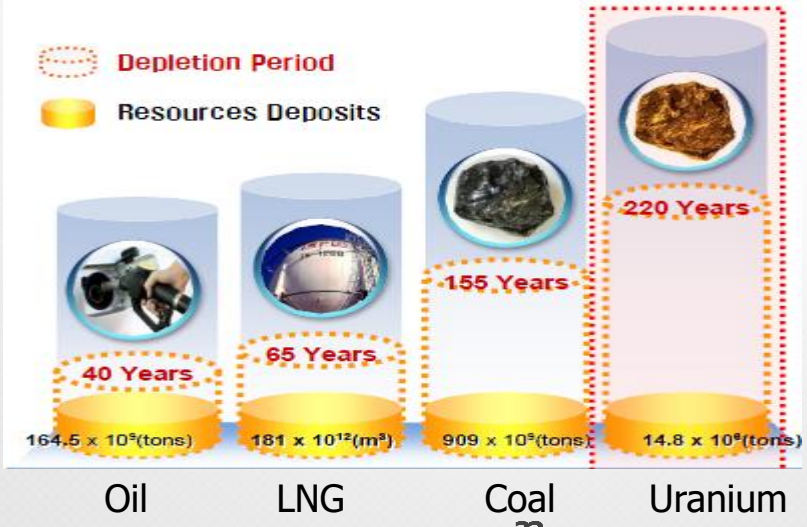
CO_2 Emissions (g/kWh)



Unit price (won/kWh, 2013)

Coal	Oil	LNG	Solar	Nuclear
58.9	221.7	215.3	371~567	39.1

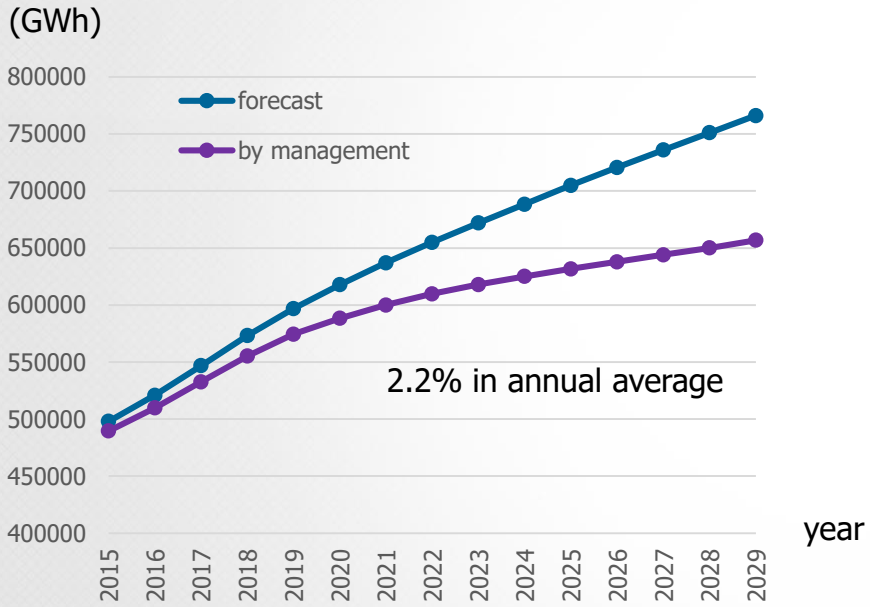
Fuel deposit (global)

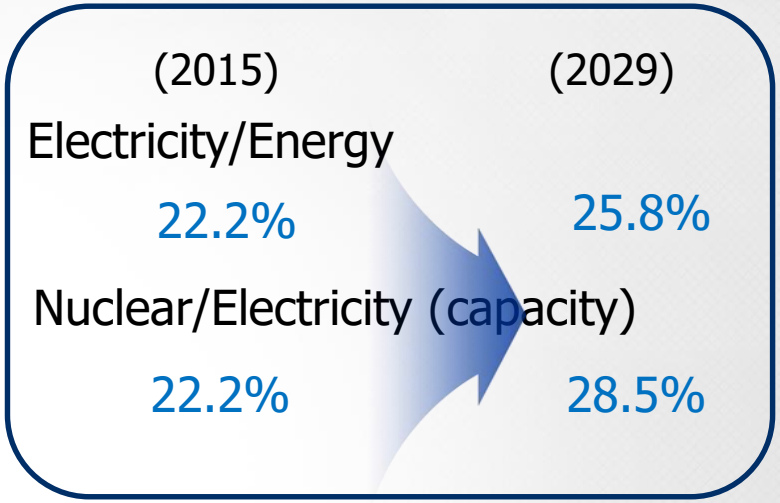


- Lowest cost of fuel(10%)
- Long-term storage of fuel
- Base load power
- Supply stability

Long-term Energy Prospect of Korea (2015)

[Electricity demand prospect of 2nd Energy Basic Plan]





Nuclear power generation