Policies to Enhance the Safety and Public Acceptance of Nuclear Power Plants in Korea

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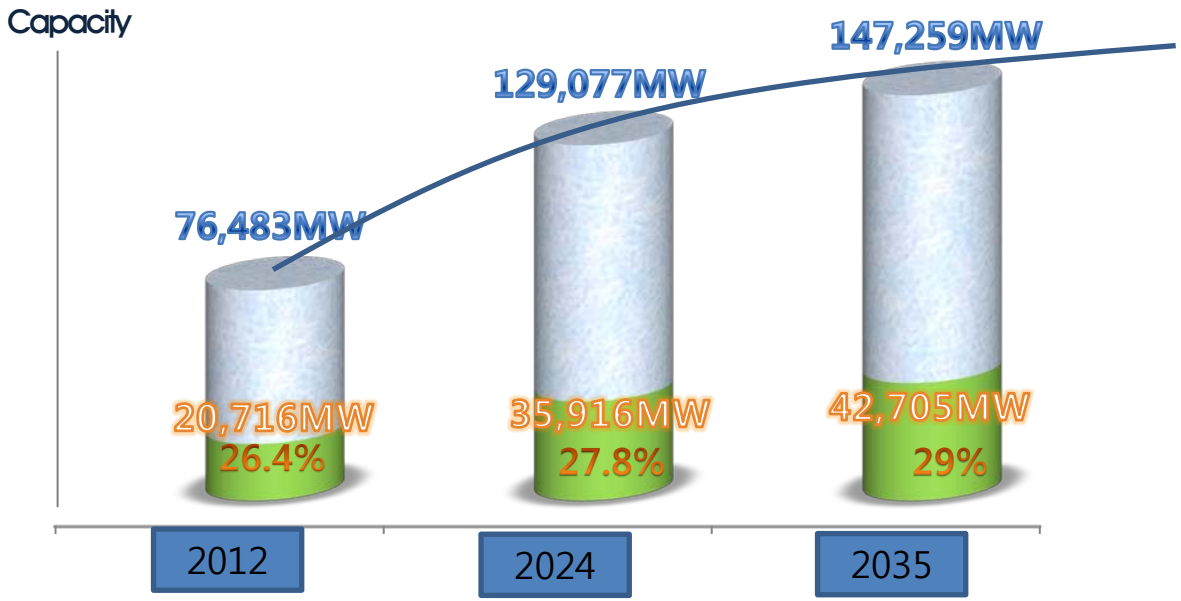
Current status and prospects
(the 2nd energy master plan)



- A total number of 34 plants(36GW) will operate until 2024
  - A total number of 23 plants are in operation as of July 2014
  - 5 plants under construction, and 6 plants planned
- The total capacity of 2035 is expected to be 147GW, and the nuclear capacity will reach 43GW
- Uncertainty related with nuclear capacity
  - The 14 plants (12GW) will be ended their lifetime unless life extension

Reasons for expansion of nuclear power plants

- Influential contribution to national energy security in a situation of absolute insufficiency of energy resources and non-connection of electric network between countries
  - Experience of the second oil shock threatening the country's dependence on oil
- Reliable alternatives for decrease of green house gas emissions
- Substantial economic advantages according to the evaluation result of levelized cost

Levelized cost (the 2nd energy basis plan, CF 80%)

unit: won/kWh

	Nuclear power	Coal	Gas
Construction cost	25.03	16.32	10.66
O & M cost	18.16	5.73	4.69
Fuel cost	3.16	40.28	104.21
Total	46.86	62.33	119.57

- Increase in difficulties of achieving the goal of nuclear plant expansion
  - Public acceptances of nuclear power decrease due to the public's growing concern about safety
  - Difficulties of building transmission line due to demand for large-capacity transmission network

International Nuclear Event Scale(IAEA)

Level	Definition	People and environment	Defence in depth	Example
7	Major accident	Major release of radio active material with widespread health and environmental effects requiring implementation of planned and extended countermeasures	Major release of radio active material with widespread health and environmental effects requiring implementation of planned and extended countermeasures	Chernobyl, Ukraine, 1986 / FUKUSHIMA 1 , 2011 Major release of radio active material with widespread health and environmental effects requiring implementation of planned and extended countermeasures
6	Serious accident	Significant release of radioactive material likely to require implementation of planned countermeasures,	Significant release of radioactive material likely to require implementation of planned countermeasures,	Kyshtym, Russia, 1957
5	Accident with wider consequences	Limited release of radioactive material likely to require implementation of some planned countermeasures Several deaths from radiation		Windscale, UK, 1957; Three Mile Island, 1979
4	Accident with local consequences	Minor release of radioactive material unlikely to result in implementation of planned countermeasures other than local food controls, At least one death from radiation,		
3	Serious incident	Exposure in excess of ten times the statutory annual limit for workers, Non-lethal deterministic health effect (e.g., burns) from radiation,	Near accident at a nuclear power plant with no safety provisions remaining, Lost or stolen highly radioactive sealed source, Misdelivered highly radioactive sealed source without adequate procedures in place to handle it,	Sellafield, UK, 2005
2	Incident	Exposure of a member of the public in excess of 10mSv Exposure of a worker in excess of the statutory annual limits	Significant failures in safety provisions but with no actual consequences, Found highly radioactive sealed orphan source, device or transport package with safety provisions intact, Inadequate packaging of a highly radioactive sealed source,	Atucha, Argentina, 2005
1	Anomaly		Overexposure of a member of the public in excess of statutory annual limits, Minor problems with safety components with significant defence-in-depth remaining, Low activity lost or stolen radioactive source, device or transport package	

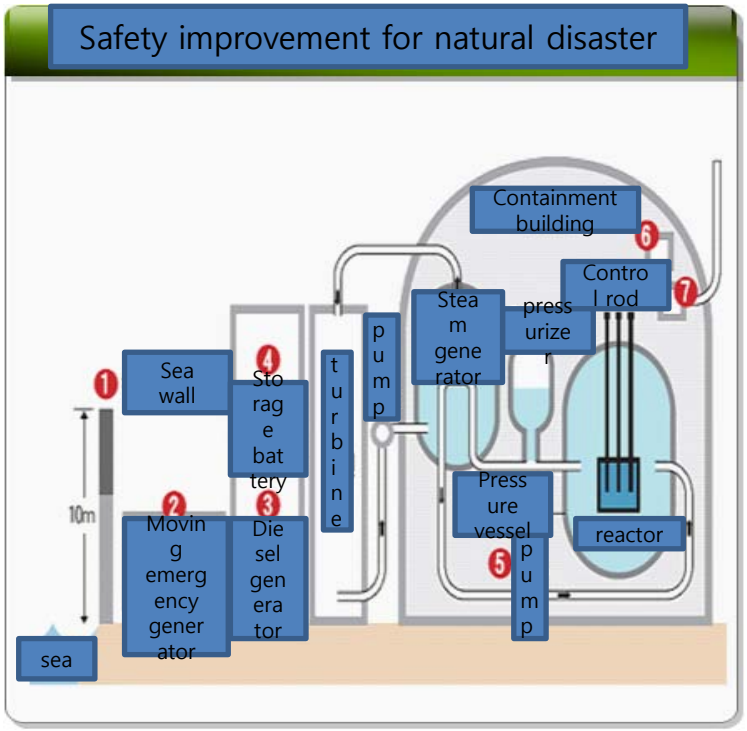
System for securing safety of nuclear plants

Design Base	①	Construction & Operation	obtaining licensing of operation through PSAR, FSAR
	②	Regular test	safety confirmation through performance and operation test during O/H
	③	PSR for each Decade	Periodic safety review for each decade
	④	Safety test for life extension	PSR, assessment of NSSS lifetime, assessment of radiological impact
Beyond Design Base	⑤	Measures after Fukushima	emergency plan for earthquake, flood, serious accident, tsunami
	⑥	Stress test	disaster prevention and emergency plan of earthquake, flood, serious accident

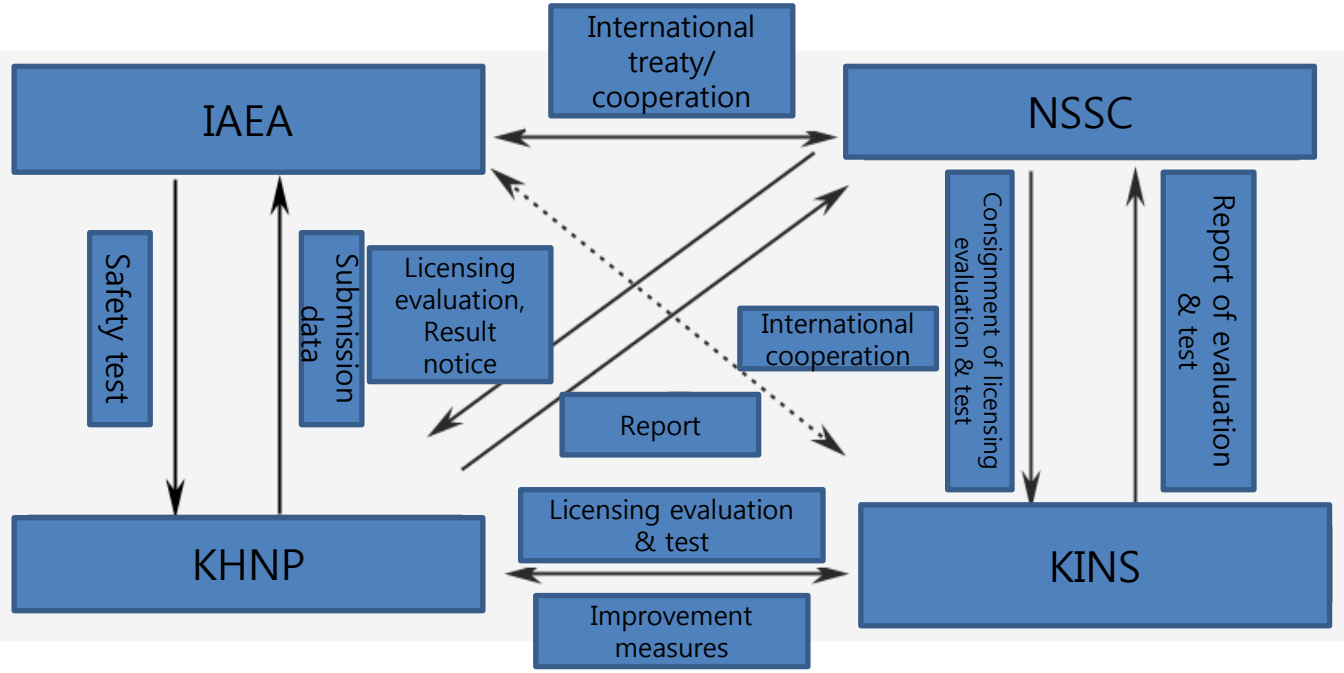
Measures for safety improvement after Fukushima

☐ Implementation of safety tests on nuclear plants and introduction of safety improvement Investment after the Fukushima Daiichi nuclear reactor accident
☞ KHNP carrying out 50 improvement measures

☐ Implementation of 50 short and long term measures
① Increase building of sea wall of the Gori nuclear plant from 7.5m to 10m
② Prepare the generator car nuclear site
③ Install waterproof doors blocking water flow into emergency diesel generators
④ Secure emergency storage battery in flooding-resisting locations
⑤ Application of waterproofing of pumps
⑥ Install hydrogen removal equipment operating without electricity and prevention of hydrogen explosion
⑦ Install exhaust and depressurization equipment blocking pressure increase of containment vessel
>> invest around 1.1 trillion won for 5 years



Safety management system



- NSSC : Nuclear safety and security commission
- KHNP : Korea Hydro & Nuclear Power Co., LTD
- KINS : Korea Institute of Nuclear Safety

Disaster prevention system of nuclear plants

Category	Organizations for emergency	Functions / roles
NSSC	Central radiation disaster prevention measures center	Control of national radiation disaster
	On-site radiation disaster prevention control center	Radiation disaster control and management
Local governments	Provincial radiation disaster prevention measures center	Implementation of resident protection measures (evacuation, etc)
KINS	Radiation protection technical service center	Technical support for recovery of radiation disaster -radiation exploration and prevention measures against radiation pollution
Institute of radiological & medical sciences	Radiation emergency medical service center	Medical treatment for radiation victims
nuclear plants	Emergency operation facility of nuclear plants	Prevention measures against accident within nuclear facilities, & recovery activities and information provision

Efforts to improve safety

- Analysis result of composite index of WANO(World Association of Nuclear Operators) safety and performance (as of December 2012)

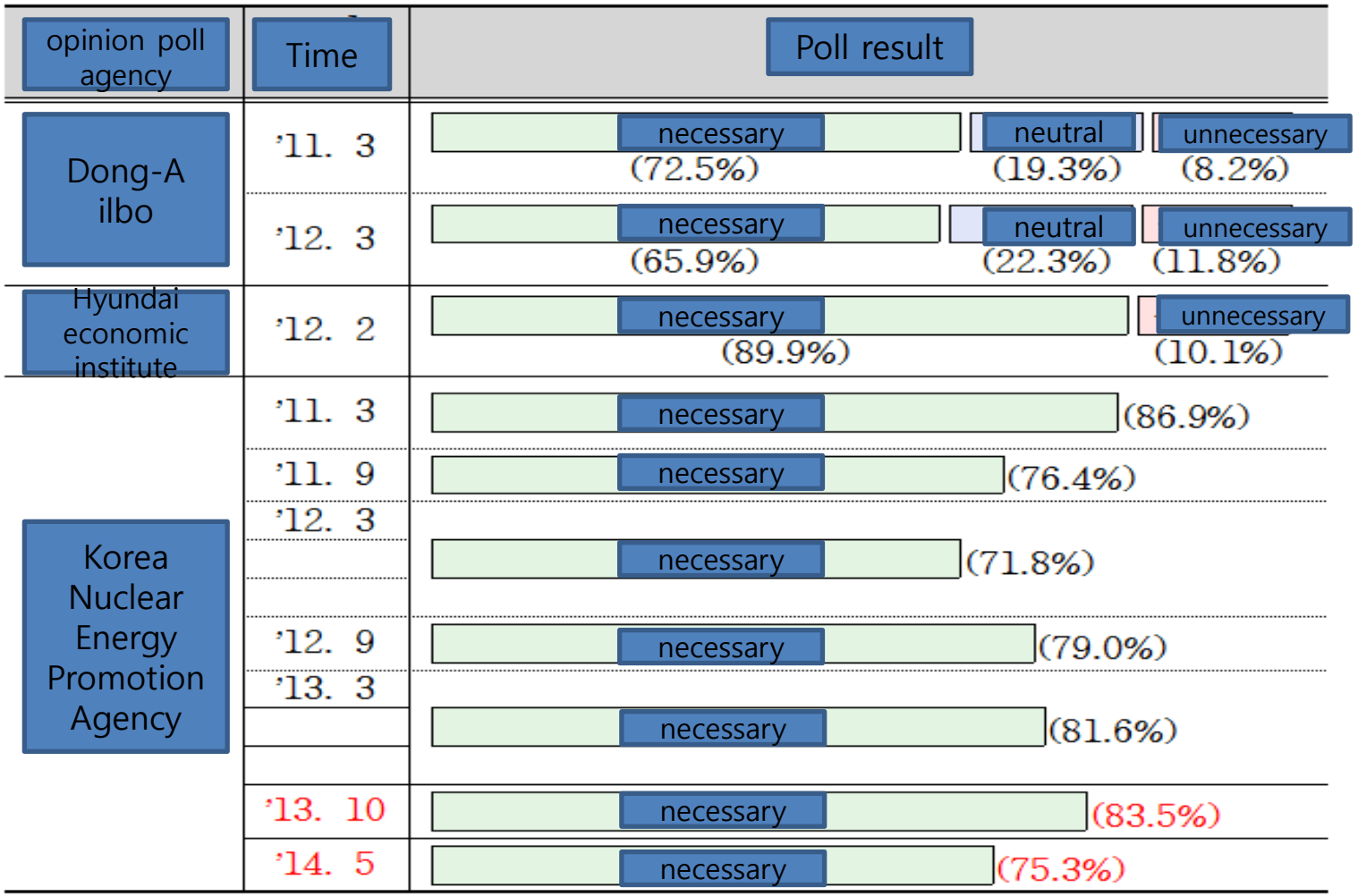
Countries	China	Korea	USA	Ukraine	India	France	Canada	Sweden
Points	92.5	91.5	89.0	82.9	79.1	75.2	73.5	68.3

- Increase safety equipment of operating and serious accident
  - Decrease Core Damage Frequency (CDF) to 1.0E-5/RY

- Newly developed APR+
  - Decrease CDF to 1.0E-6/RY

Result of public opinion poll - Necessity

○ Necessity of nuclear power plants : a majority of the public agrees with it



Result of public opinion poll - Safety

○ Safety of nuclear plants: the public concerns growing after nuclear accident of the Fukushima Daiichi reactors

opinion poll agency	Time	Poll result
Dong-A ilbo	'10년	safe (31.9%) neutral (45.0%) worrying (23.0%)
	'12. 3	safe (35.2%) neutral (28.3%) worrying (36.5%)
Seoul Federation for Environmental Movement	'12. 2	worrying (53.5%)
Korea Nuclear Energy Promotion Agency	'10.12	safe (71.0%)
	'11. 3	safe (51.4%)
	'11. 9	safe (45.4%)
	'12. 3	safe (34.0%)
	'12. 9	safe (53.3%)
	'13. 3	safe (43.6%)
	'13. 10	safe (31.2%)
	'14. 5	safe (29.8%)

Result of public opinion poll – capacity ratio

○ Proportion of nuclear plants: the results vary depending on opinion poll agency and contents of question

opinion poll agency	Time	Poll result
Dong-A ilbo	'11. 3	expansion (27.7%) / maintain (38.6%) / reduction (33.6%)
	'12. 3	expansion (21.7%) / maintain (34.5%) / reduction (43.8%)
Seoul Federation for Environmental Movement	'12. 2	expansion (35.1%) / reduction (64.9%)
Korea Nuclear Energy Promotion Agency	'13. 3	expansion (54.7%) / maintain (22.2%) / reduction (17.7%)
Korea Nuclear Energy Promotion Agency	'13. 7	expansion (45.2%) / reduction (17.3%)
	'13. 10	expansion (40.3%) / reduction (21.7%)
	'14. 5	expansion (37.3%) / reduction (27.3%)
Korean Federation for Environmental Movement	'13.11	expansion (43.9%) / maintain (21.6%) / reduction (34.5%)

Implementation of policies for improving safety/public acceptance

- Increase independence of regulatory agency and expertise of the agency's officials
- Expansion of disclosure about the information including nuclear plant operation data, and provision of related procedures
  - ※ Japan: publicized process of "Innovative Energy Environment Strategy"
    - Information provision DB, hearing of public opinion, survey of public opinion (poll survey in discussion style), etc.
  - ※ the U.S. : NRC
    - Real time broadcast of conference, disclosure of conference schedule and conference recording on the internet website
    - Decide the degree of the public's participation by defining it as category 1, 2, 3 based on conference subjects
- Measures for recovery of reliability of nuclear operators
  - Expand external audit of NGO
  - Carry out policies for safety improvement including personnel reorganization and innovation of organization culture
  - Eradication of corruption
  - Ban on retirees' reemployment for subcontractors
  - Quality improvement including innovation of part purchase
    - ✓ Real time monitoring of material purchase · management
    - ✓ Introduction of the competitive part purchase system
    - ✓ Part quality test by the third institution, etc.

Thank you