Extension of Nuclear Energy Use for Future

2010 conference of Win-Global

May 12, 2010

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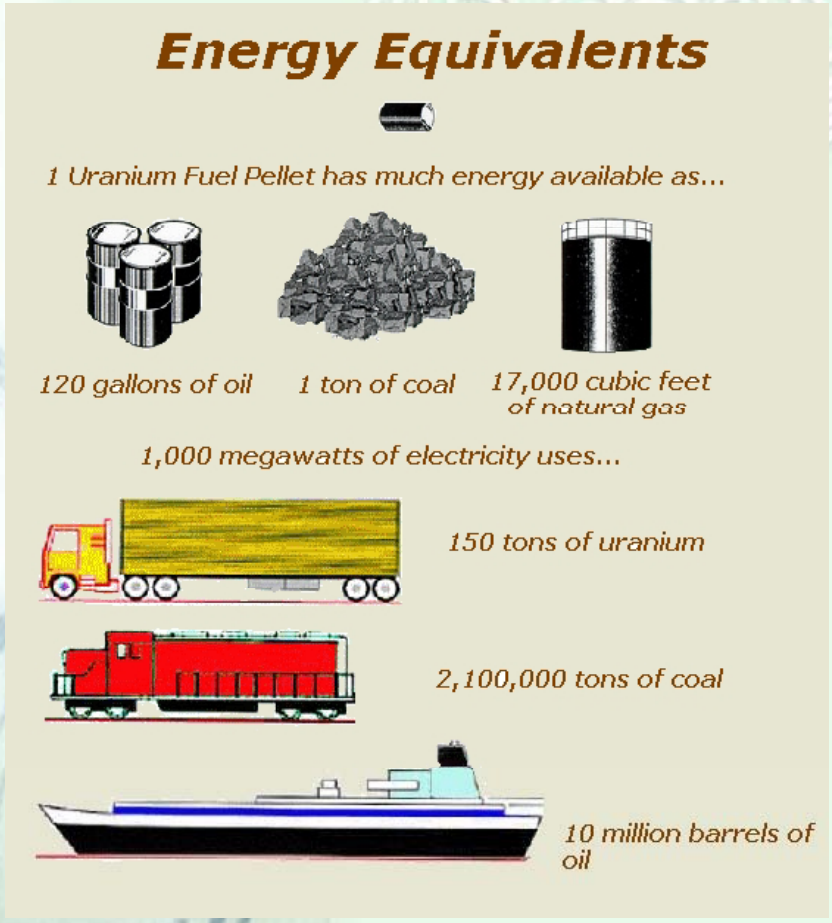
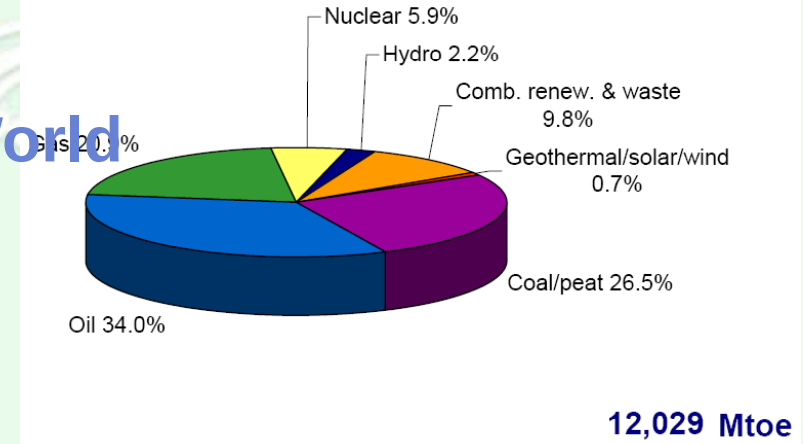
Seoul National University

1. Nuclear Energy Supply



Ref) World Nuclear Association

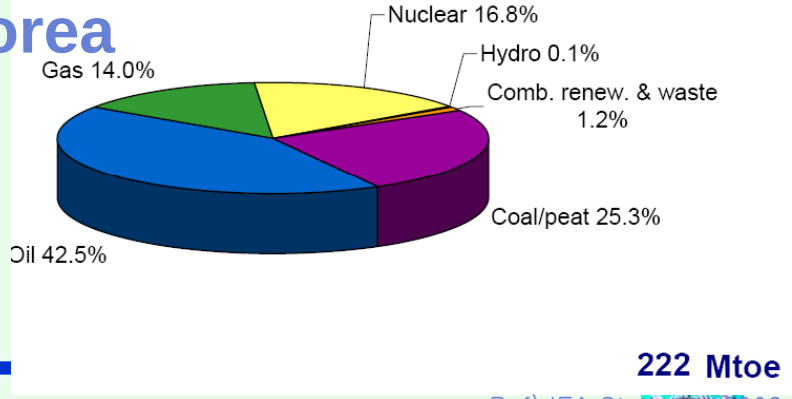
World



12,029 Mtoe

World 5th Nuclear country

Korea

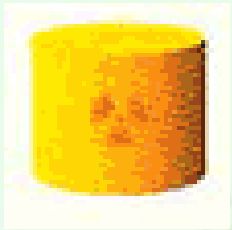


222 Mtoe

Ref) IEA Sta[illegible]009

Additional Emission of CO_2 when replacing nuclear energy by fossil energy

nuclear = oil = Natural gas = coal

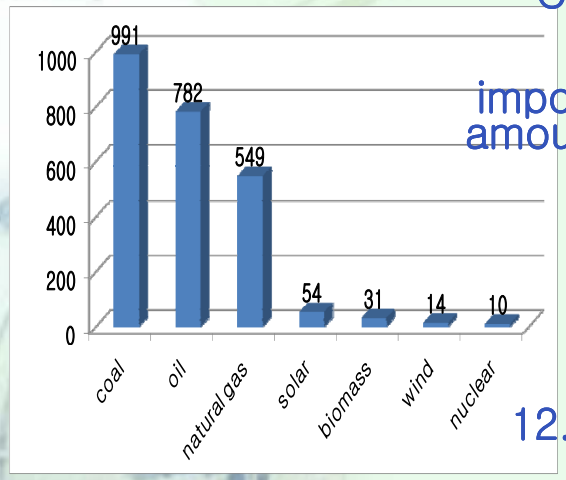


142.9 billion kWh

110 million ton of CO_2 emission

77 million ton of CO_2 emission

140 million ton of CO_2 emission



CO2 Emission by Energy

import amount

12.4 trillion won

import amount

9 trillion won

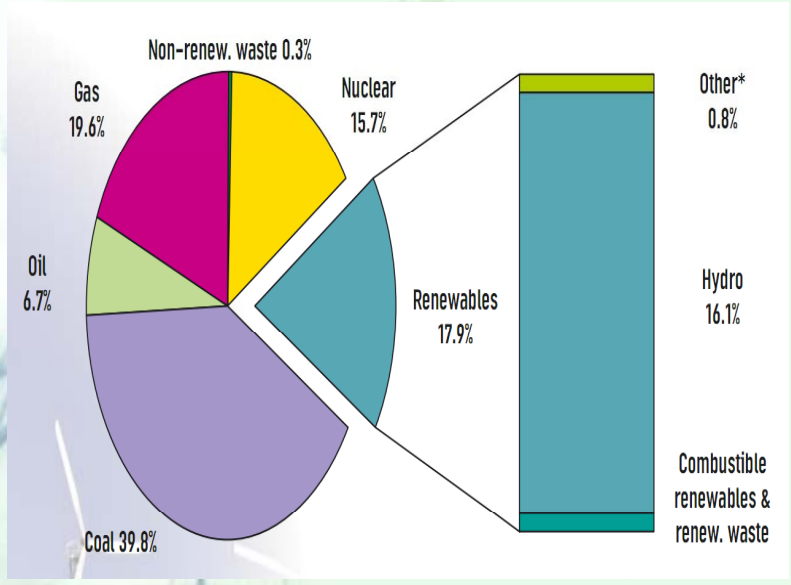
import amount

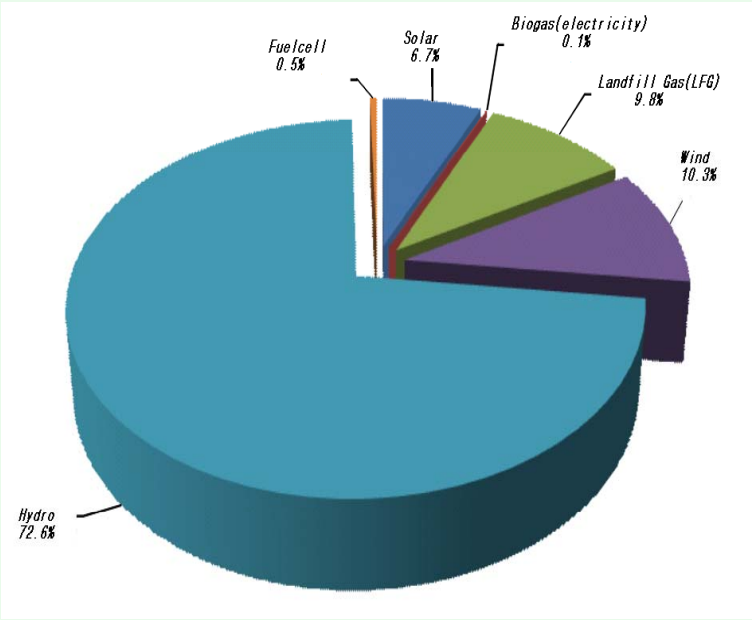
3.2 trillion won

◆ Renewable Energy

A. World power generation by renewable energy
= 3,179,000GWh (17.9% of total electricity production)

B. Korea power generation by renewable energy
= 4,227,476 MWh (1% of total electricity production)





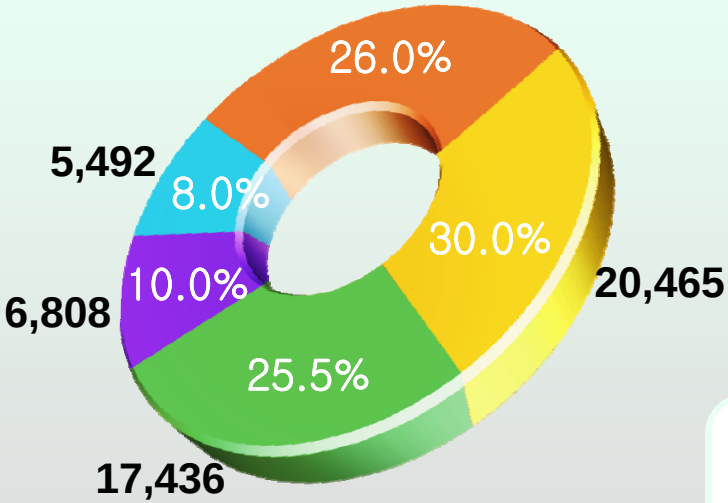
Source : IEA Energy Statistics

Status of Nuclear Power

World 5th Nuclear Country

Installed capacity

17,716MW

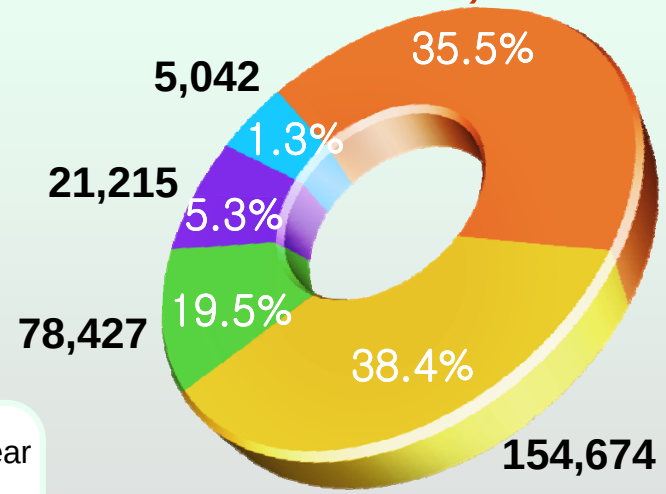


*The others : 351 MW(0.5%)

Total : 68,268 MW

Generating capacity

142, 937GWh



*The others : 829 GWh(0.2%)

Total : 403,124 GWh

Nuclear
Coal
LNG
Oil
Hydro

(2007년말 기준)

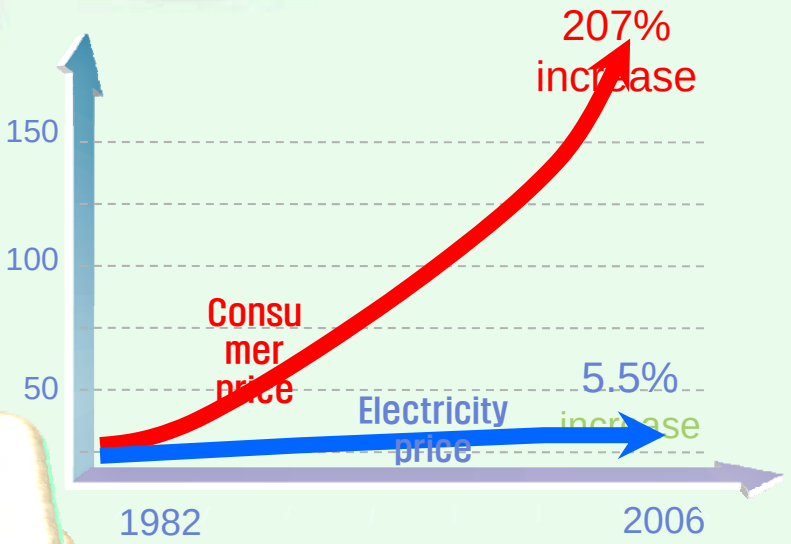
Stepping-Stone of Han River Miracle

Eagerness of Young Engineers for New Technology

Devotional Passion of the Education

Strong Political Leadership

Serious National Need for Energy Security



◆ Nuclear Market

- Potential Countries

  1) North Africa and Middle East

  ; Iran, Algeria, Jordan, Libya, Morocco, Tunisia , United Arab Emirates(UAE), Egypt, Israel, Jordan, Kuwait, Qatar, Syria, Yemen, Saudi Arabia and Bahrain.

  2) Asia

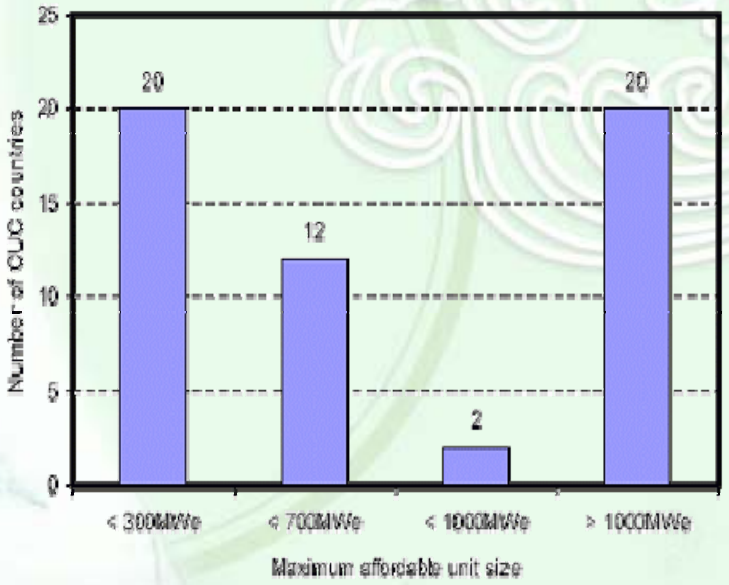
  ; Thailand , Vietnam , Indonesia, Bangladesh

  3) EU

  ; Albania, Croatia, Montenegro, Bosnia , Poland, Estonia , Latvia , Turkey

- Expect new construction of300 Units by2030 and 1400 units by 2050 (IAEA)
- 100,000 construction personnel by 2030년
- 10,000 high-quality nuclear experts

Market for SMR(Small & Medium Reactor)



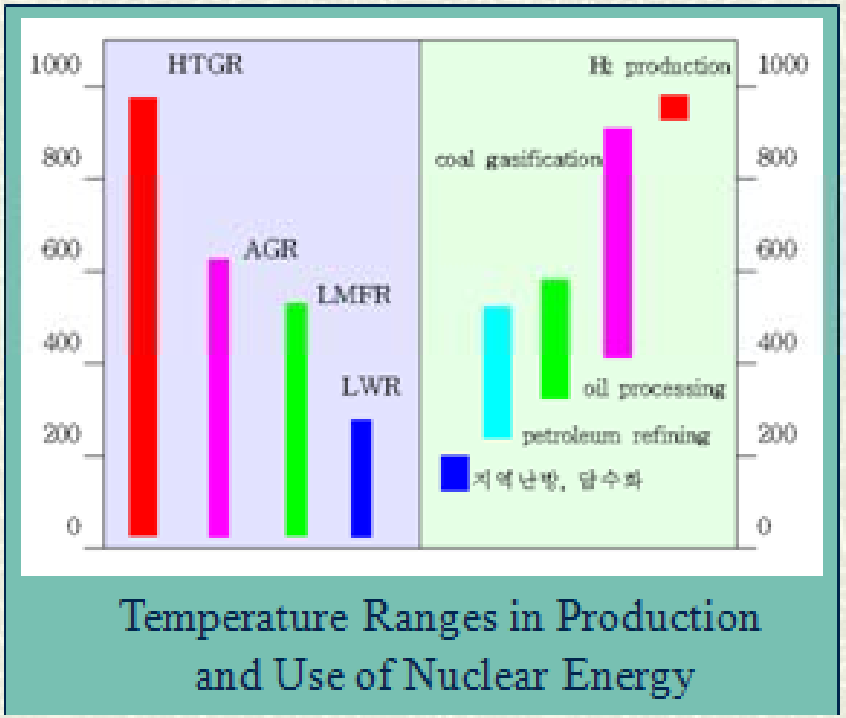
- IAEA(2008) expects 20 countries will construct less than 300MWe units, among 54 nuclear potential countries.

Market Estimate for SMR

- 400 ~ 850 Units (CRIEPI, Japan)
- 500 ~1,000 Units by 2050 (US DOE/GNEP)
- $350 Billion World Market (STEPI/IAEA)

Non-Electric Applications of Nuclear Energy

- Primary energy
  - ◇ 30% : electricity
  - ◇ 70% : heat, steam, transportation, etc
- Temperature range in production and use of nuclear energy
  - ◇ Low temperature
    - district heating
    - Desalination
    - transportation
  - ◇ High temperature
    - coal gasification
    - H2 generation : AVR, THTR-300, HTTR, HTR-10



Temperature Ranges in Production and Use of Nuclear Energy

2. Development of Future Reactors

☛ Diverse Grid and Regional Energy

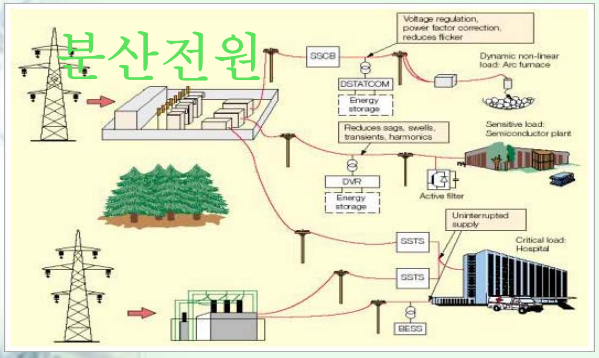
- Small and Medium reactors (100MWe ~ 300MWe)
- micro-reactor for micro-grid (< 100MWth)
- desalination, district heating, process heating

⇨ *Development of S&M, inherently safe reactors is inevitable for the future.*

☛ Era of Hydrogen Economy

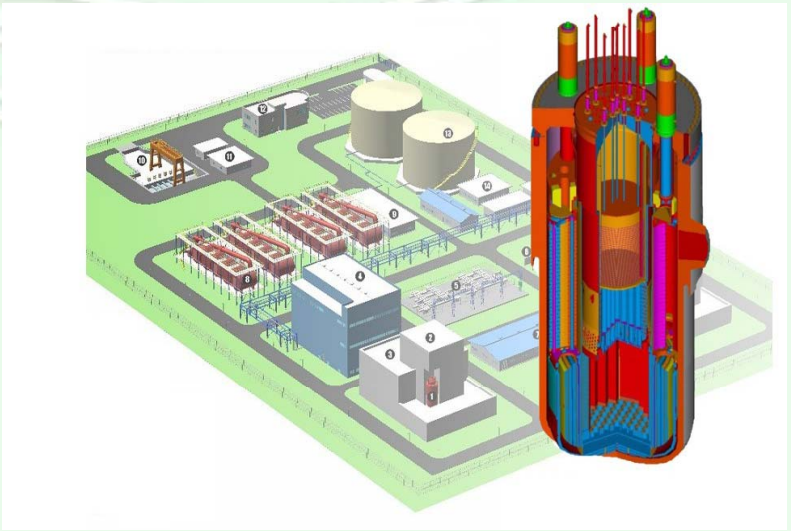
Oil Economy ⇒ Hydrogen Economy

Change of Energy Supply Paradigm



❖ Desalination Reactor

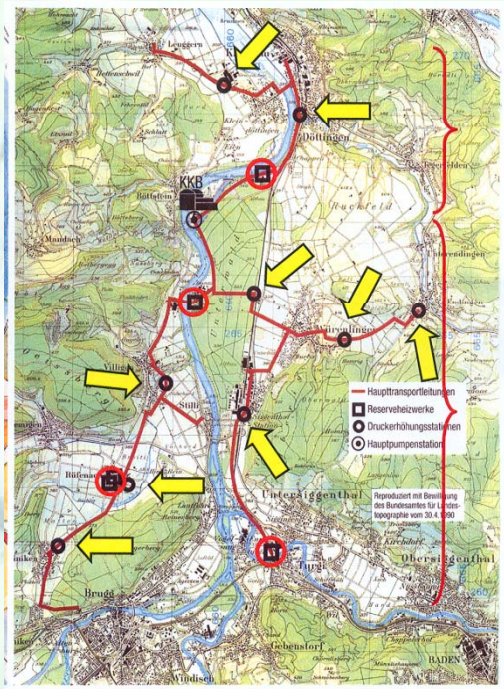
- **The desalination of sea water is the only long-term alternative to cope with the world-wide water struggle.**
- Status of sea water desalination
  ; Middle East (70%), Europe (9.9%) , California and Florida (7.4%), Africa (6.3%), Asia (5.8%)



- Desalination reactors
  Korea, Canada, China, Kazakhstan, Russia, Ukrine
  ; SMART(330MWt), NRH, RUTA, KLT-40C, MARS(이태리)
  Morocco and Indonesia : feasibility study under IAEA support

  ※ SMART330 in Madura island of Indonesia

REFUNA for Nuclear District Heating



Our District Heating Net

Northern part 10 km
Southern part 21 km

9 decentral pumping stations

5 boilers for emergency back up with total 77 MW (located at different places)

Pipelines ø 350 – 20 mm
31 km main pipeline system
99 km local distribution net

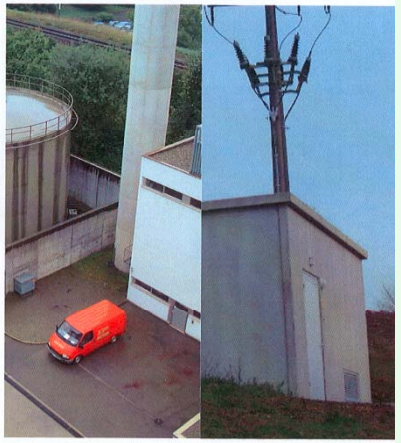
Total of 260 km of piplines

All of them have leakage supervision

REFUNA

resources

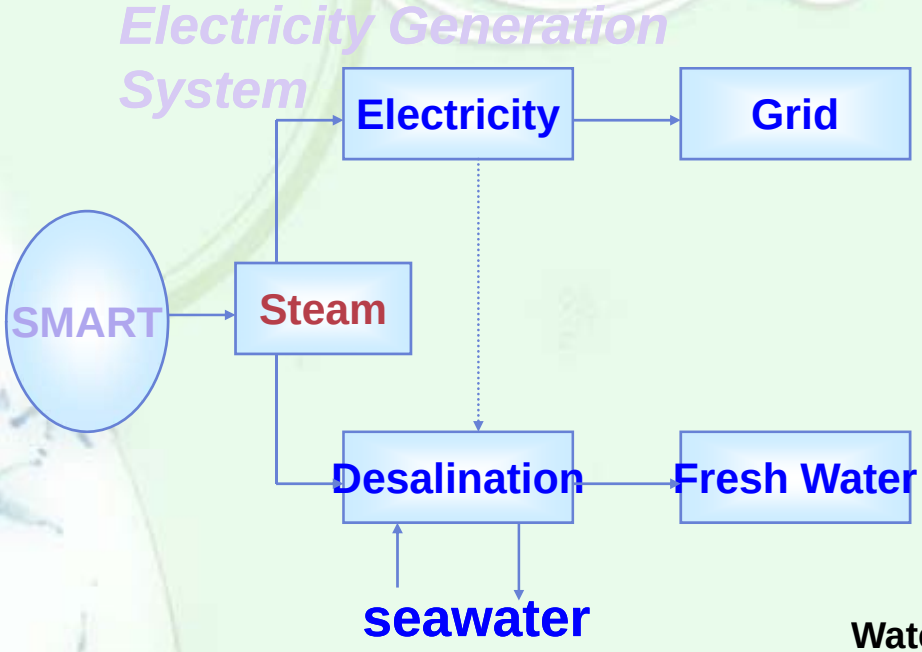
Main Pipeline System



REFUNA

SMART Development Program in Korea

- System integrated Modular Advanced ReacTor
- Integrated Nuclear Desalination System

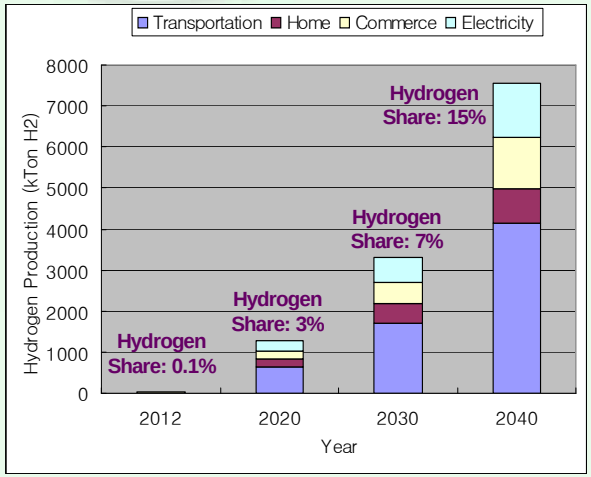


System (Plant) Concept

- **SMART Thermal Power : 330 MWt**
- **Desalination Process : MED**
- **Water Production : 40,000 tons/day**
- **Electricity Generation**
  - **Efficiency : ~ 30%**
  - **To the Grid : ~ 90 MWe**

Water and Electricity Supply to the Area with Approximately 100,000 Population or to an Industrial Complex

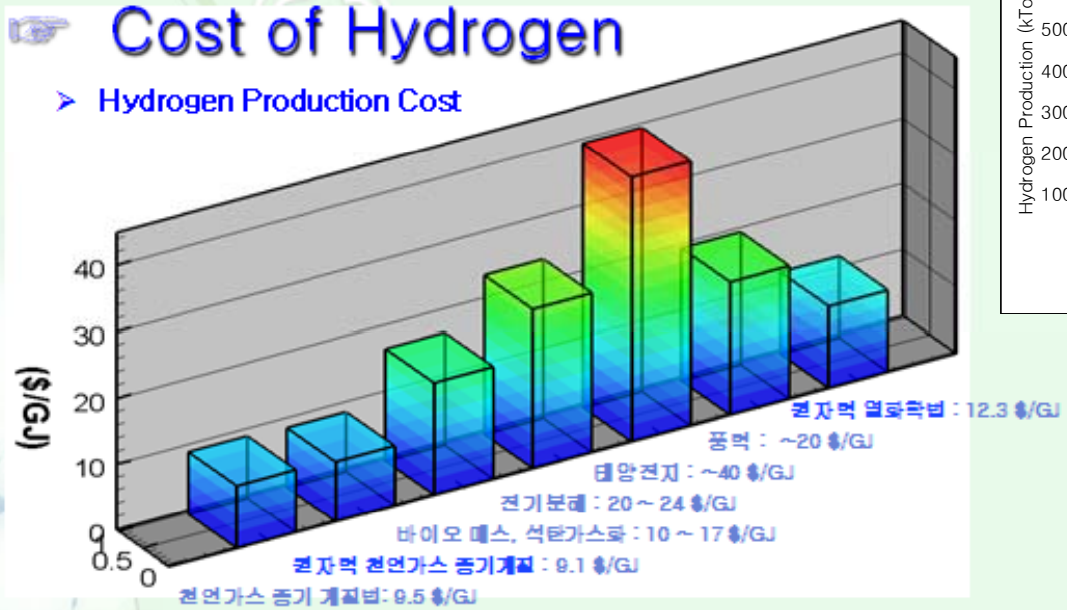
3. Development Program of Hydrogen Generating Reactor in Korea



National Vision of Hydrogen Economy … (MOCIE, 2005)

Cost of Hydrogen

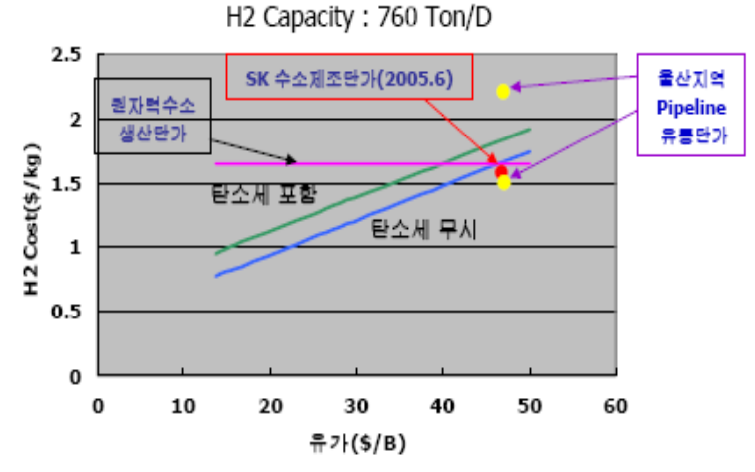
- Hydrogen Production Cost



- Removal cost of CO_2 for Methane steam reforming = 7 ~ 8 $/GJ

Why Nuclear Hydrogen in Korea?

- Energy Demand in Korea
  - Energy Demand: 192.9 MTOE in 2000 ⇨ 311.8 MTOE in 2020
    Energy Import in 2000: 97% (~ 53% is Oil (~ 75% from Middle East))
    More than Half of Oil Demand Increment is from Transportation Sector
  - Korean Government pursues Early Entrance into Hydrogen Economy
- Why Nuclear Hydrogen?
  - Limitation of Fossil Energy Resources
  - Climate Change
  - Energy Security: Unrest of Oil Price, …
  - Self-Reliant & Technology-Lead Energy:
    Fuel Cost < 5% of Generating Cost



⇨ *Economic and Massive Production of Hydrogen (20% of Transportation Energy in 2020's) using CO_2 Emission-Free Nuclear Technology*

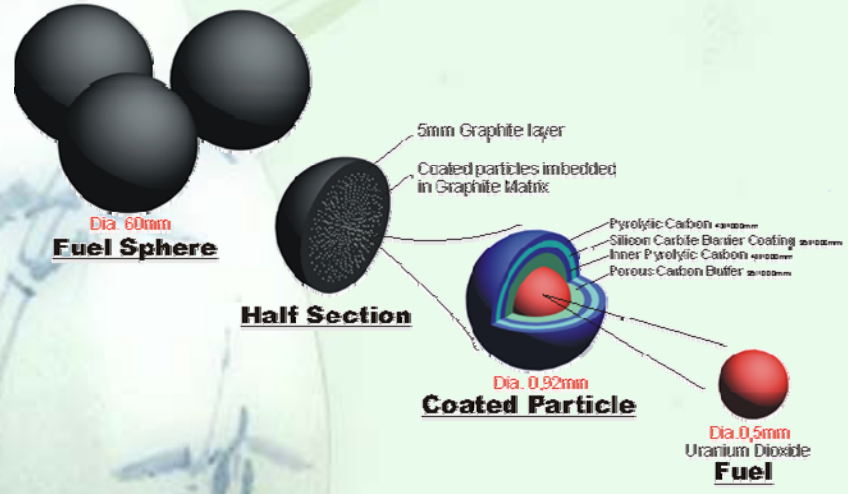
Limitation in using Renewable Energy

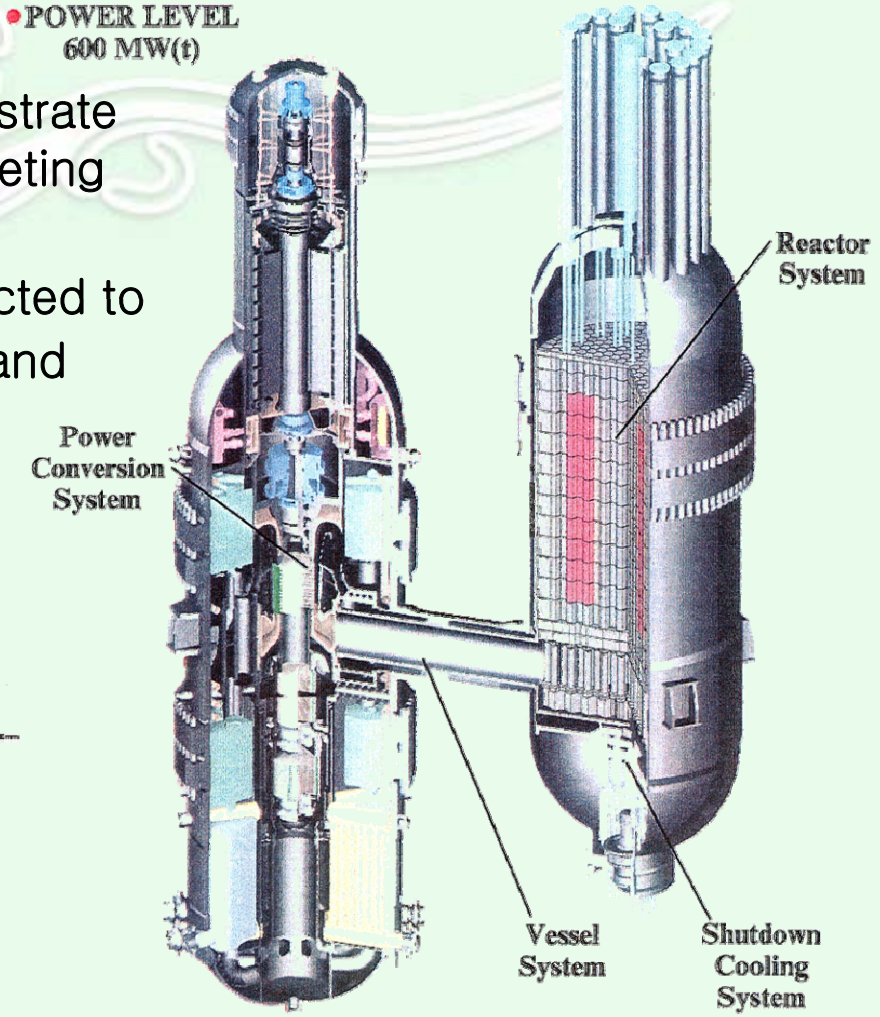
	Nuclear	Solar	Wind
Capacity per Plant	1,000,000kW	300kW	1,000kW
Relative # of Plants (Load Factor)	1 (80%)	21,875 (12%)	4,000 (20%)
Generating Cost	5.9 yen/kWh	66 yen/kWh	9–14 yen/kWh
Equivalent Investment Cost	360 Byen	7,000 Byen	1,000 Byen
Area	< 0.2 km^2	67 km^2	248 km^2

❑ 수소생산용 원자로 개발(NHDD Project)

❑ NHDD* Project

- Design, Construct and Demonstrate Nuclear Hydrogen System targeting Commercialization in 2025
- 15 Year National Project expected to be supported by Government and Industry





4. Nuclear Use in Ocean

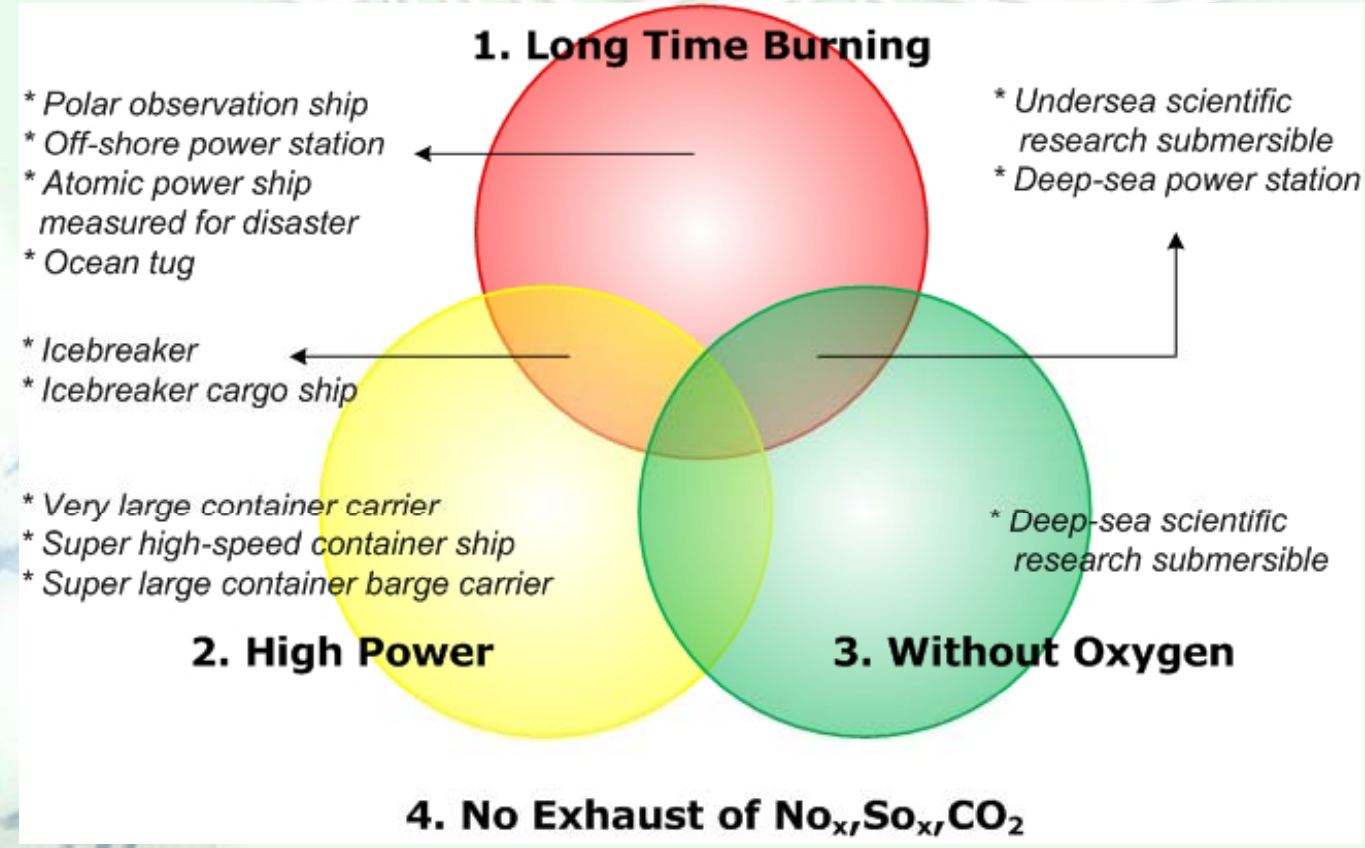
- Nuclear Icebreaker
- Nuclear Deepsea Explorer
- Large and High-Speed Nuclear Container
- Floating Nuclear Power Plant

III. 세계 원자력선 현황

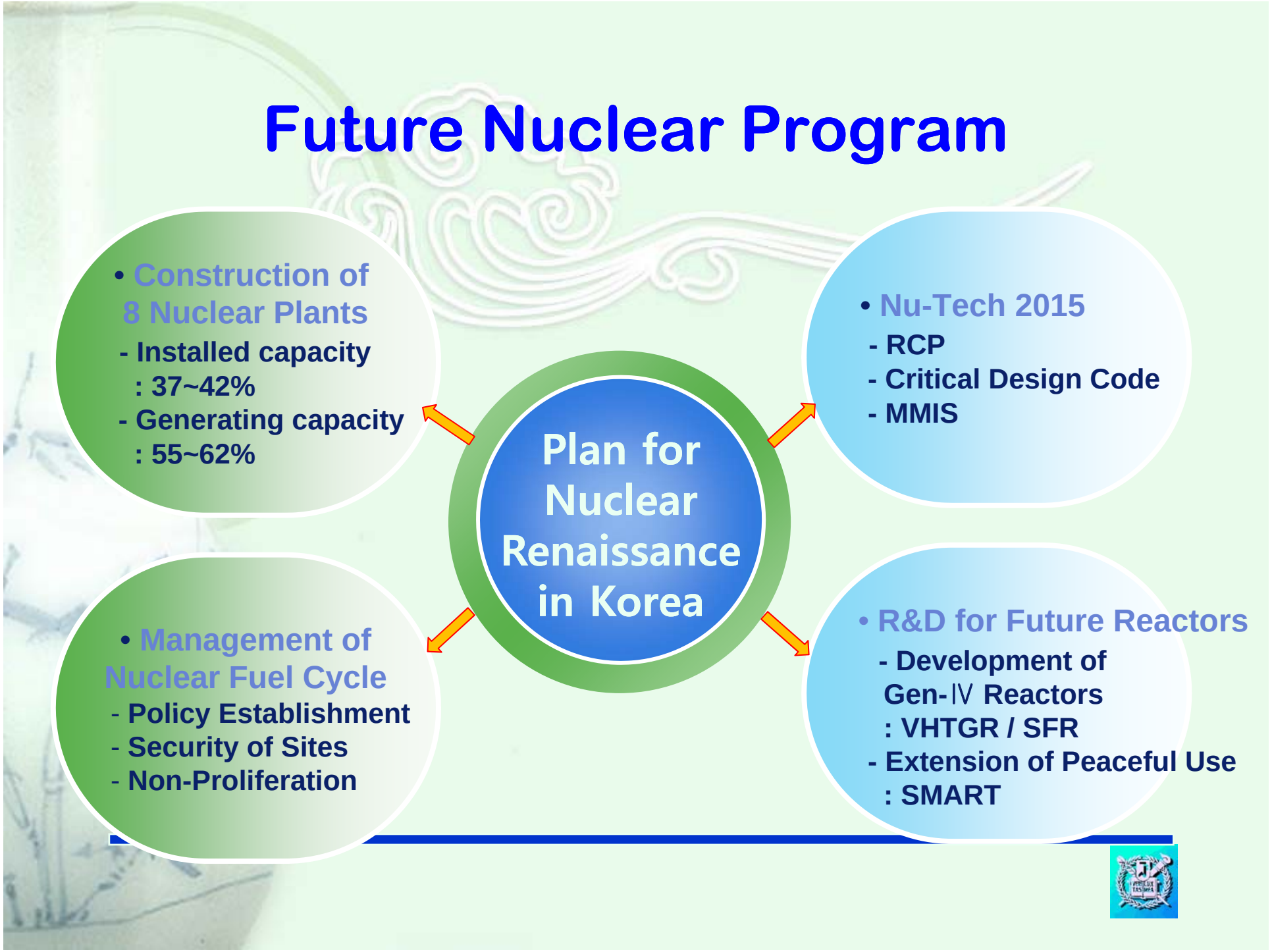
船名	單位	시반나	오토한	무쓰	레닌	알크지카	시비리	러시아	세브모푸후	타이미르	소비에트키슈즈	바이카지	十月革命	우랄	사카N
선종		화객선	공작운반선	실험선	쇄빙선	쇄빙선	쇄빙선	쇄빙선		쇄빙선	쇄빙선	쇄빙선	쇄빙선	쇄빙선	잠수모선
전장	m	181.7	170.0	130.0	134.0	147.9	147.9	150.0	260.3	151.8	150.0	151.8	150.0	159.6	38
최대폭	m	23.8	23.4	17.0	27.6	29.9	29.9	30.0	32.2	29.2	30.0	29.2	30.0	30.0	7.4
만수	m	8.99	9.2	6.9	10.5	11.0	11.0	11.0	10.7	8.1	-	8.1	-	-	-
배수량	ton	21,850	25,812	8,241	17,810	20,905	21,120	22,920	61,000	20,000	22,920	20,000	23,400	25,800	>625
속력	knot	24	17	17.5	19.6	20.8	20.8	20.8	20.0	18.5	20.8	18.5	20.8	-	6(수중)
원자로출력 × 기수	MW	75.2×1	38×1	36×1	90×2	150×2	150×2	150×2	135×1	171×1	150×2	171×1	150×0	150×2	1.5×1
쇄빙능력	m	-	-	-	1.5	2.2~2.3	2.2~2.3	2.4~2.5	1.0	1.7~1.8	2.4~2.5	1.7~1.8	2.4~2.5	2.6~2.7	-
탑선자수	人	170	91	80	170	130	130	130	76	104	130	104	130	-	13
기공년월일		1988.5	1988.9	1988.11.27	1959.5.28	1971.7.3	1972.12	1981.1	1984.11	1984.11	1988.11.2	1985	-	1986秋	
진수년월일		1959.7	1964.6.13	1969.6.12	1957.12.5	1972.12.25	1976.2.20	1988.11.2	1986.4.20	1987.4.10	-	-	1990 春	1988.여정	
완성년월일		1962.5	1988.12.17	1991.2.14	1959.9.23	1974.11	1977.10	1985.12	1988.12.31	1989.6.17※	1989.12.29	1990.7.29	1990.여정	1994.여정	1988.여정
비고										※초임계					

Introduction to Marine Reactor

- Why nuclear power on ocean shipping?



Future Nuclear Program



5. Tasks to extend nuclear energy to non-electric application

- economic predominance ↔ modularization, once-piece removal maintenance
- Transparent fuel cycle ⇨ non-proliferation
- extreme safety ↔ passive safety technology
- Public Accetance