Climate Policy after Fukushima
16th Annual Meeting of the REORM Group
Schloss Leopoldskron, Salzburg, Austria
August 29 – September 2, 2001

Nuclear Power in South Korea

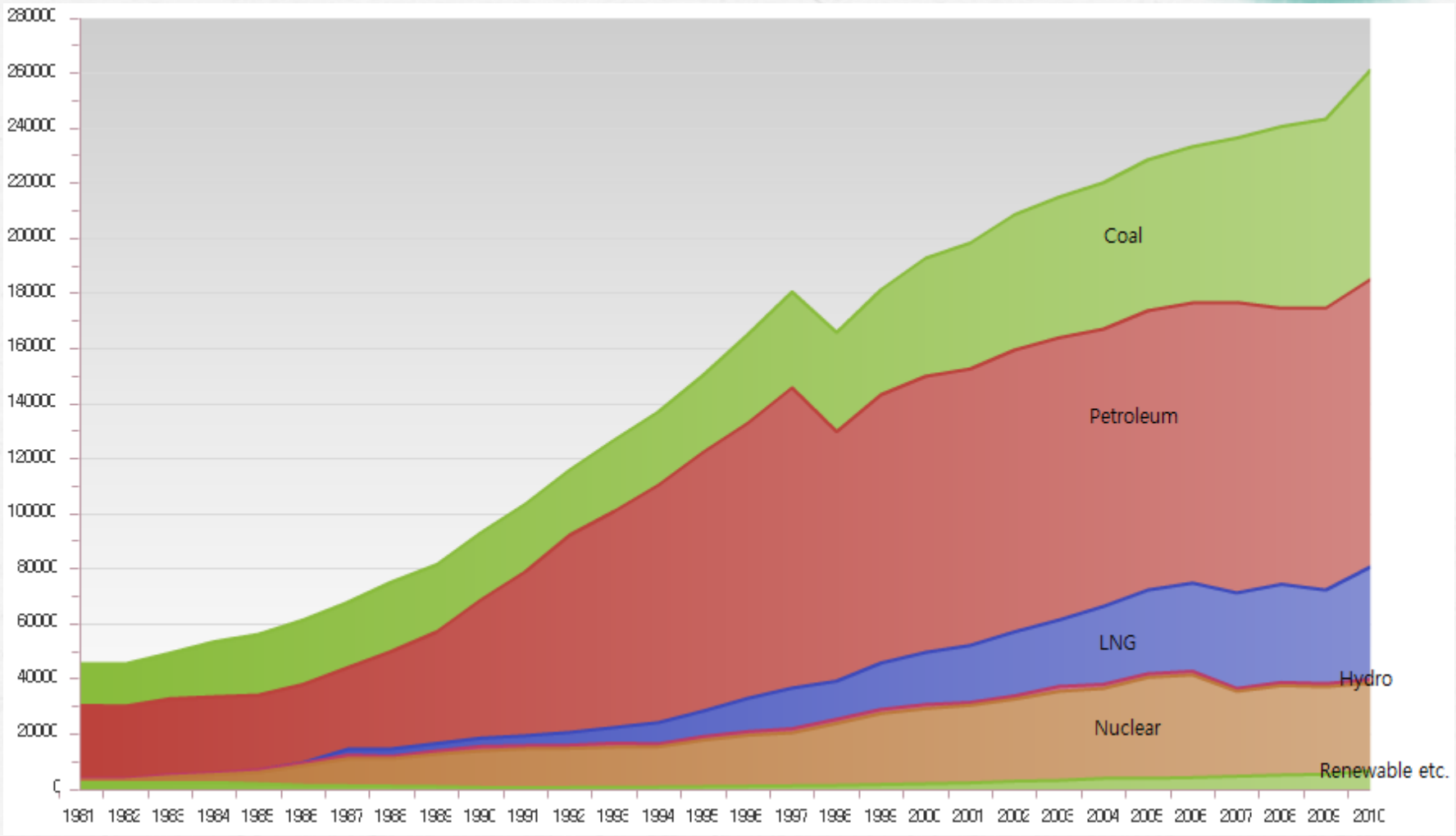
Leem, Sung-Jin
(Jeonju University, South Korea)

Contents

I. Overview of Energy Consumption and Production in South Korea

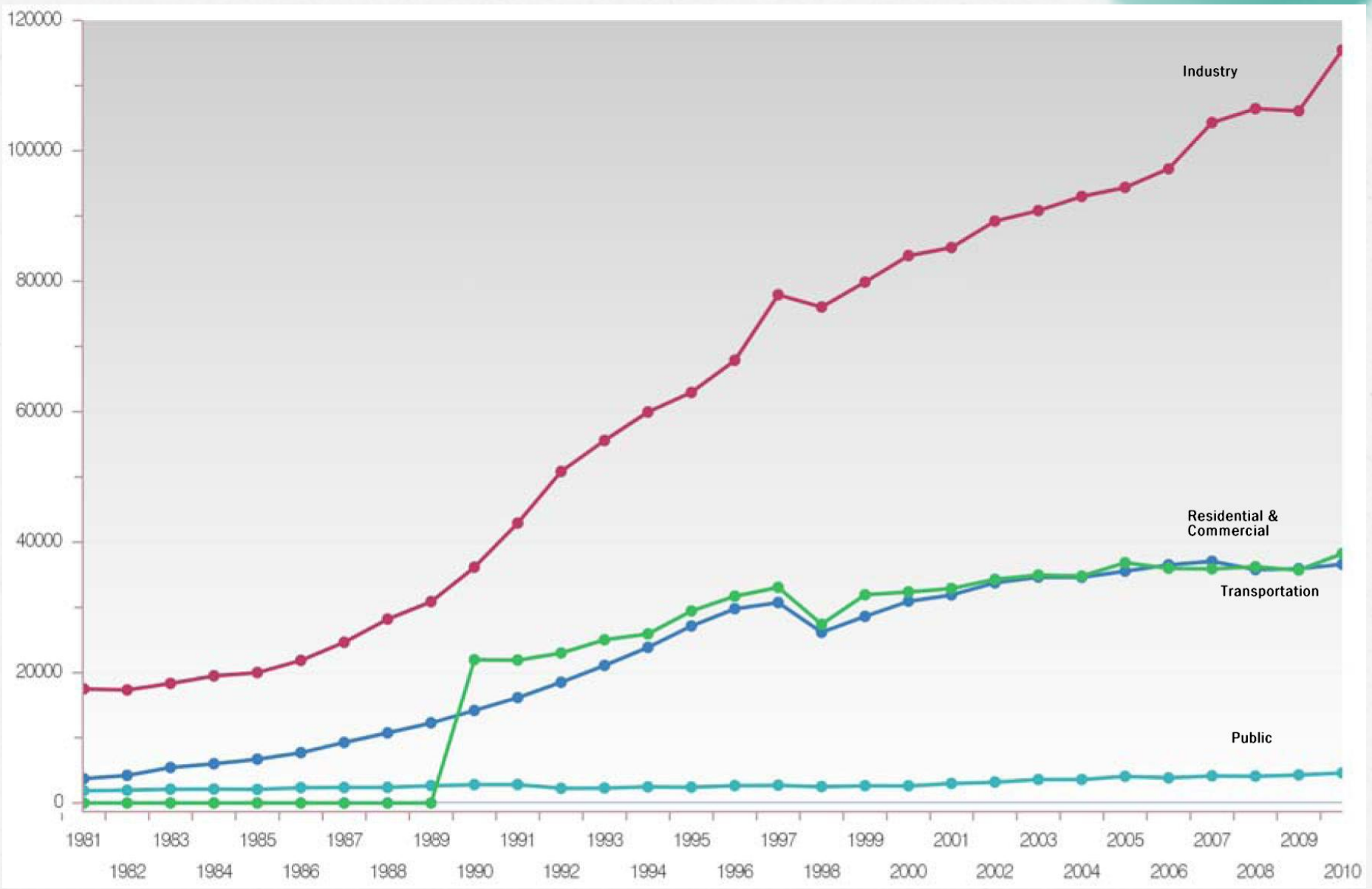
1. Energy Consumption
2. Electricity and Nuclear Power

Primary Energy Consumption (1,000TOE)

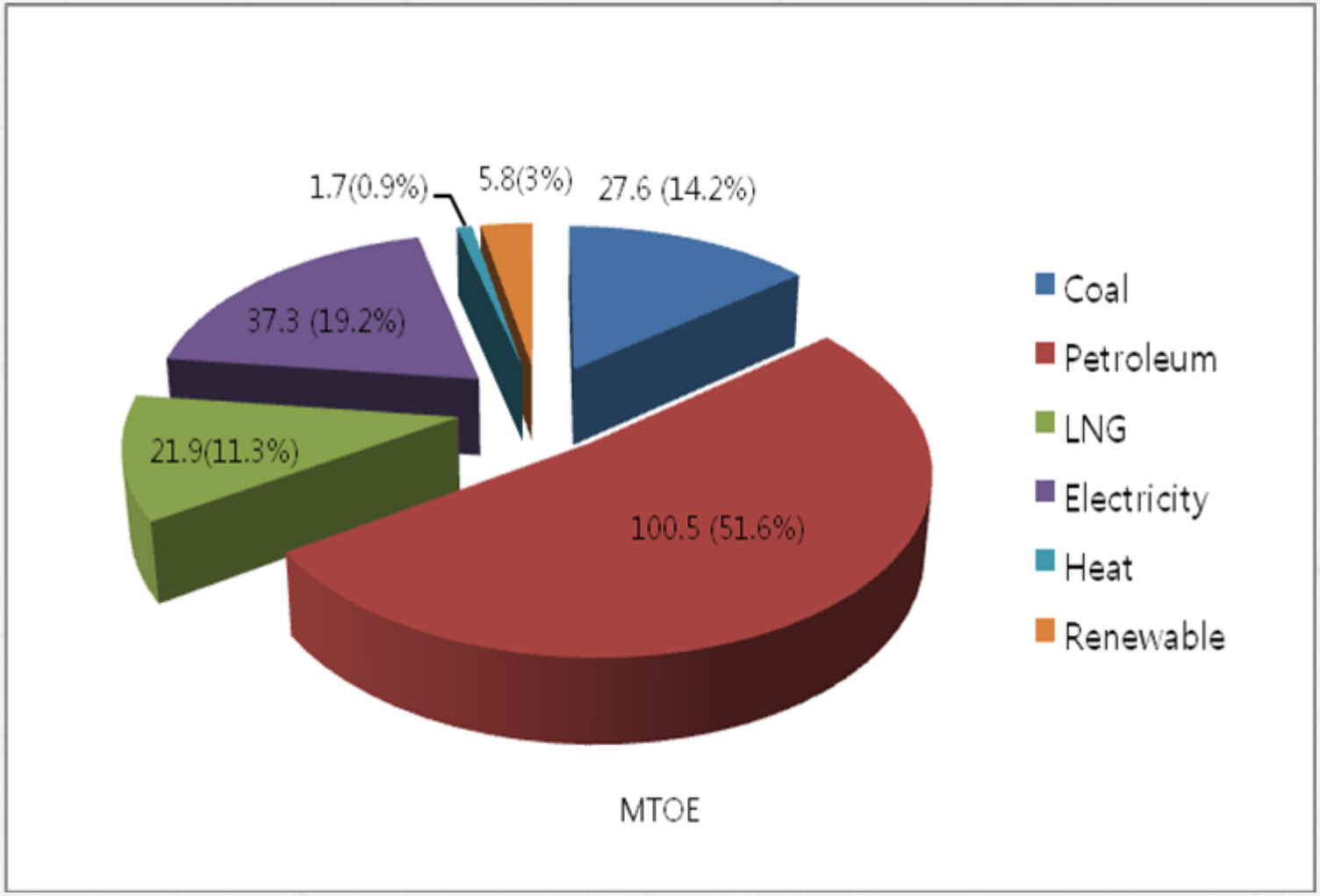


KESIS 2011

Final Energy Consumption from 1990 (1,000TOE)



Final Energy Consumption by Sources (in 2010)



Overview : Electricity and Nuclear Power

- **Electricity Consumption**
- the ninth largest consumer in the world
- 35,424 GWh (1981)→ 434,160 GWh (2010)
- much higher growth rate than that of final and primary energy consumption (by 12 times)
- Industry is the largest electricity consumer (54)

- **Electricity Production**
- 40,207 GWh (1981)→ 474,660 GWh (2010)
- Fossil fuels provided 66.5% (coal 40.9%, oil 5.3%)
- Nuclear 31.3%, hydro 1.4%, alternative energy 0.8%

Generation by Energy Sources (GWh)

KEPCO 2011b

Installed Generating Capacity by Energy Sources (MW)

KEPCO 2011b

Overview : Nuclear Power

- 21 nuclear power units in operation
- total generation capacity : 18,716 MW (2. 2011)
- the 5th largest producer of nuclear electricity in the world
- 17 Pressurized Water Reactors (PWR) and
  4 Pressurized Heavy Water Reactors (PHWR)

  - PWR account for about 85 per cent of generating capacity.

II. Nuclear Policy in South Korea

- IAEA membership in 1957
- Atomic Energy Law in 1958
- Office of Atomic Energy in 1959

  - a governmental research institute

  - the first laboratory reactor, TRIGA Mark-II, from the U.S
- Energy Plan in 1971, detailing the construction of three reactors, each with about 600 MW capacity
- the first nuclear reactor in South Korea, Kori unit 1, started generating in 1978

- In 1983 Kori 2 and Wolsung 1

- Kori 1 and 2 : pressurized water reactors
- Wolsung 1 : CANDU-type of heavy water reactor(PHWR)

- During the 1980s :

- Korea was one of only three countries of the OECD to sustain nuclear plant orders beyond 1980
- during the second half of the 1980s, completed six more reactors, quickly expanding the nuclear power industry capacity
- In 1989 nine reactors in operation, accounting for 34% of electricity generating capacity and 45% of the power supply in South Korea

Technical Development

- Acquisition of technical self-reliance

- Signing contract with Combustion Engineering (now Westinghouse) in 1986 on condition of transferring relevant nuclear technology

- Korean Standard Nuclear Power Plant (KSNP), used as the prototype for eight 1,000 MW reactors

  - Younggwang # 3, 4; Ulchin # 3 - 6

- Improved KSNP : OPR1000 or KSNP

- Shinkori # 1(2. 2011), 2(12. 2011)
- Shin-Wolsong # 1(3. 2012) and 2(1. 2013)

Technical Development

- APR-1400, Next Generation Reactor
  - improved version of the 1400 MW-PWR
  - having evolved from the US System 80+
  - an exported model to the UAE
  - Shin-Kori # 3(9. 2013) & 4(9. 2014)
  - Shin-Ulchin units # 1(6. 2016) & 2(6. 2017)
  - Shin-Kori # 5(12. 2018) & 6(12. 2019)
- developing an indigenous 1,500-megawatt Advanced Power Reactor by 2012

Unit	Installed Capacity (MWe)	Reactor Type	Main Contractor	Starting Construction	Commercial Operation
Kori #1	587	PWR	Westinghouse	'72.04.27	'78.04.29
Kori #2	650	PWR	Westinghouse	'77.12.04	'83.07.25
Kori #3	950	PWR	Westinghouse	'79.10.01	'85.09.30
Kori #4	950	PWR	Westinghouse	'80.04.01	'86.04.29
Shin-Kori #1	1000	PWR (KSNP+)	Doosan	'06.06.16	'11.02.28
Wolsong #1	679	PHWR	AECL	'77.10.30	'83.04.22
Wolsong #2	700	PHWR	AECL	'92.06.22	'97.07.01
Wolsong #3	700	PHWR	AECL	'94.03.17	'98.07.01
Wolsong #4	700	PHWR	AECL	'94.07.22	'99.10.01
Yonggwang #1	950	PWR	Westinghouse	'81.06.04	'86.08.25
Yonggwang #2	950	PWR	Westinghouse	'81.12.01	'87.06.10
Yonggwang #3	1000	PWR	Hanjung	'89.12.23	'95.03.31
Yonggwang #4	1000	PWR	Hanjung	'90.05.26	'96.01.01
Yonggwang #5	1000	PWR	Hanjung	'97.06.29	'02.05.21
Yonggwang #6	1000	PWR	Hanjung	'97.11.20	'02.12.24
Ulchin #1	950	PWR	Framatom	'83.01.26	'88.09.10
Ulchin #2	950	PWR	Framatom	'83.07.05	'89.09.30
Ulchin #3	1000	PWR	Hanjung	'93.07.21	'98.08.11
Ulchin #4	1000	PWR	Hanjung	'93.11.01	'99.12.31
Ulchin #5	1000	PWR	Hanjung	'99.10.01	'04.07.29
Ulchin #6	1000	PWR	Hanjung	'00.09.29	'05.04.22
total	18,716				

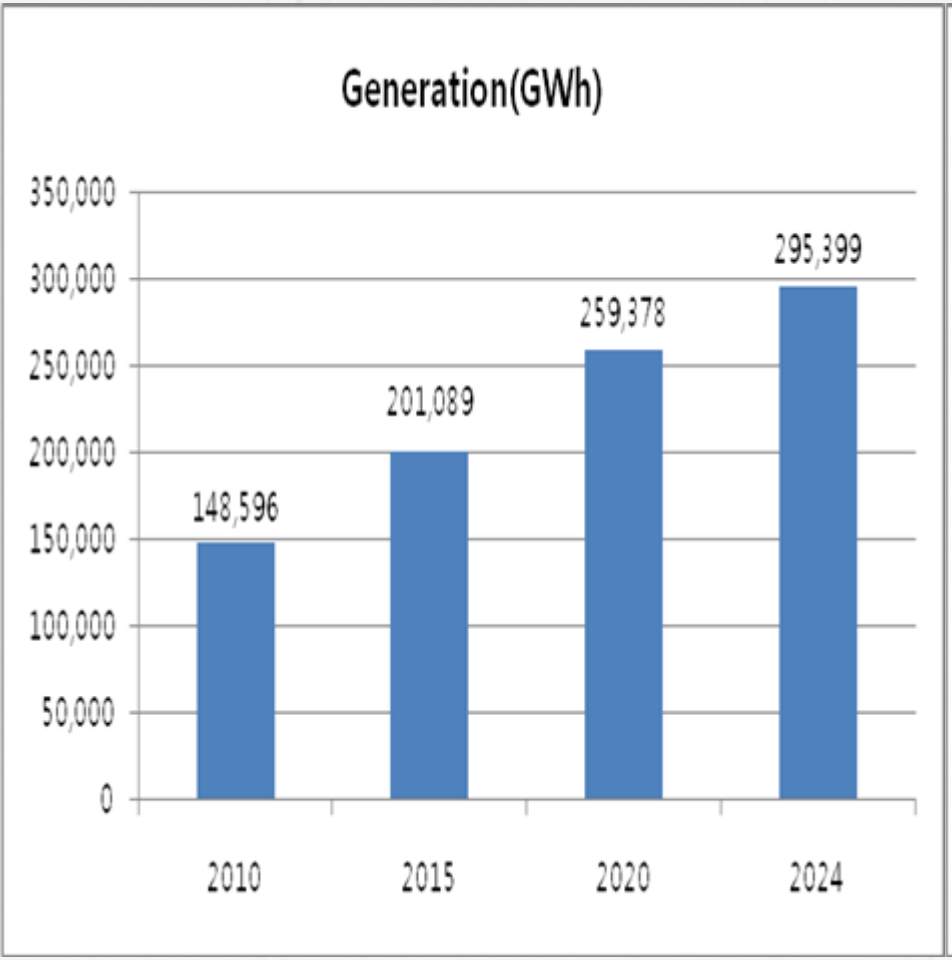
Nuclear Power Perspective

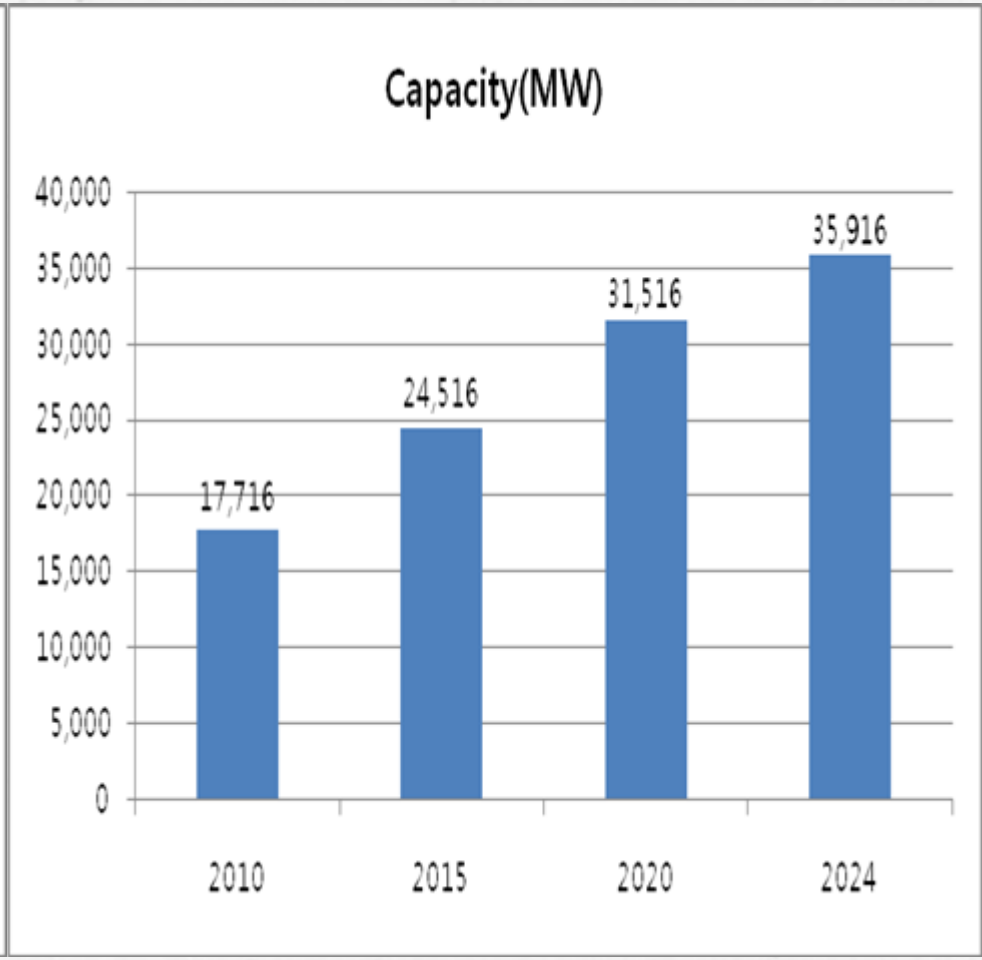
- Seven additional units to be constructed by 2017, with a combined capacity of 8,600 MW
- Plans to build six more power plants by 2024
  - 34 reactors
  - installed generating capacity of 35,916 MW total
- By 2030, plans for 38 or 39 reactors
  - Nuclear power is expected to cover almost 60% of the nation’s electricity needs.

South Korean Reactors Planned by 2024

Unit	Installed Capacity (MWe)	Reactor Type	Commercial Operation	Main Contractor	
Shin Kori 2	1000 MWe	PWR (KSNP+)	2011. 12	Doosan	under construction
Shin Wolsong 1	1000 MWe	PWR (KSNP+)	2012. 3	Doosan	
Shin Wolsong 2	1000 MWe	PWR (KSNP+)	2013. 1	Doosan	
Shin Kori 3	1400 MWe	PWR (APR1400)	2013.9.	Doosan	
Shin Kori 4	1400 MWe	PWR (APR1400)	2014.9	Doosan	
Shin Ulchin1	1400 MWe	PWR (APR1400)	2016.6	Doosan	
Shin Ulchin2	1400 MWe	PWR (APR1400)	2017.6	Doosan	
Shin Kori 5	1400 MWe	PWR (APR1400)	2018.12	—	planning
Shin Kori 6	1400 MWe	PWR (APR1400)	2019.12	—	
Shin Ulchin 3	1400 MWe	PWR (APR1400)	2020.6	—	
Shin Ulchin 4	1400 MWe	PWR (APR1400)	2021.6	—	
Shin Kori 7	1500 MWe	PWR (APR1400+)	2022.6	—	
Shin Kori 8	1500 MWe	PWR (APR1400+)	2023.6	—	

Government's Plan for Nuclear Power Generation till 2024





Fifth Long-Term Plan for Electric Power Demand and Supply (2010 - 2024)

III. Issues on South Korea's Nuclear Policy

1. Energy-wasting Policy

- Excessive forecast of energy and electricity demand, which require more nuclear power supply
- National Energy Master Plan (2008 – 2030)

  - BAU: increase by 47%, with a 1.6% yearly growth (2006 – 2030)
- Shares of nuclear energy

  - 15.9% (2006) → 27.8% (2030) in primary energy consumption
  - 17.3% (2006) → 21.3% (2030) in final energy consumption
  - 26% → 40.6% in generation capacity

1. Energy-wasting Policy

- Growing reliance on the electricity supply
- National Energy Master Plan (2008 – 2030)

(1) Share of final energy compared with the primary energy supply :

- 90% (1970s) → 74.4% (2006)
- decrease to 69% in 2030,

and accordingly increase of energy loss by 33 million TOE (60 million TOE → 93 million TOE)

(2) share of electricity in the final energy supply

- 17.3% (2006) →21.3% (2030)

- This increase of 4% = 30% expansion of primary energy consumption and 50% increase in electricity consumption .

III. Issues on South Korea's Nuclear Policy

2. Safety Issues

- 644 troubles reported since 1978

  - 20 incidents per year

- Kori NR (#1 – 4) alone are responsible for 279 reported cases (43.2% of incidents).

- Kori 1, the oldest reactor in South Korea, alone accounts for 20% of the troubles (128 times).
- Kori reactors were designed and constructed by Westinghouse.
- Many reactors of the same type have already been shut down in the US. because of defects in the steam generator and the deficiency in design and construction materials of the reactor interior.
- Operation time of Kori 1 (designed lifetime of 30 years) : extended for 10 more years (December 2007).

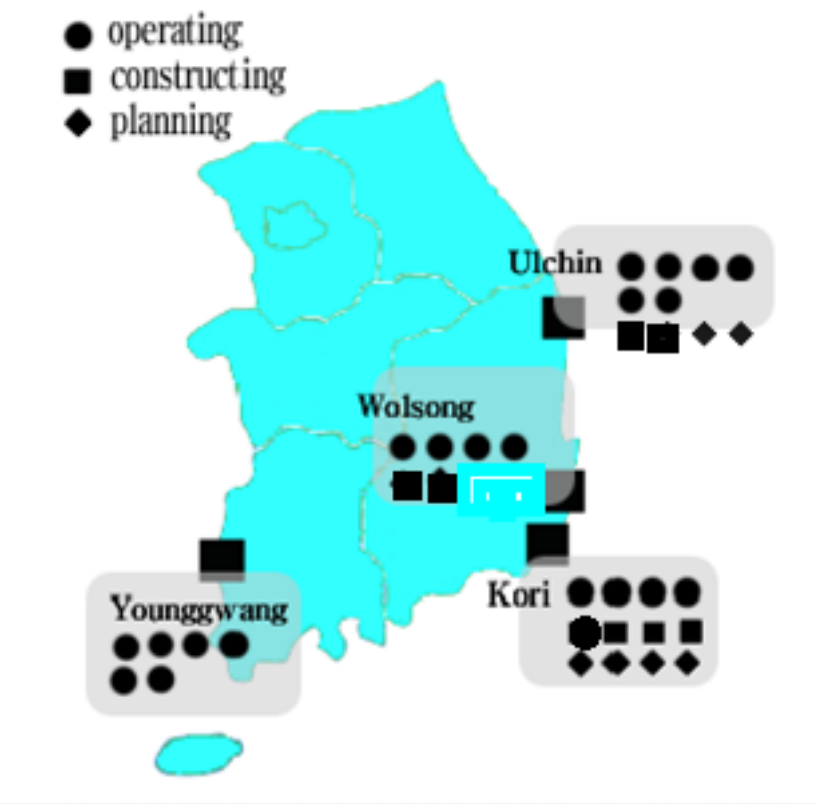
2. Safety Issues

- Kori nuclear power plants are located within a 25 km radius of two big cities, Busan and Ulsan, whose population are 3.5 million and 1.1 million respectively.

2. Safety Issues

- 10 to 12 reactors would operate altogether within one complex (by 2024)

  - the highest capacity and the largest number of units in a nuclear power complex worldwide



2. Safety Issues

- The Wolsong nuclear power site is located on a active fault line

  - However, the plant was built with a lower seismic fortification level of 0.2g, which is lower than that of a hospital, to reduce the construction costs.

- Nuclear waste repository in Kyoungju

- Weak bedrock
- More than 3,000 tons of water is spilled every day.

- Safety problem of Korean standard reactors which was introduced from Combustion Engineering
- Wolsung #1 - 4 : CANDU-type reactors which cause safety concerns on account of design defects of the cooling pipes.

IV. Conclusion: after Fukushima?

- Small changes?

- NPP (New Progressive Party) requests energy system transition and phase-out of nuclear power.
- Recently more and more politicians in opposition parties are calling for exhaustive safety check-ups on nuclear power plants and a change in Korean governmental nuclear policy in the direction of sustainable development.
- The media and people also have become more concerned about the nuclear power.
- decision by the local parliament of Kyungnam province
- to shut down the Kori #1 instantly
- to reinforce the safety standards of nuclear power plants

IV. Conclusion: after Fukushima?

- Nevertheless, these changes in recent years are not enough for converting Korean energy policy towards sustainability because South Korea's government persistently stands by the traditional energy policy paradigm, continuously expanding nuclear energy.
- The nuclear power industry of South Korea has grown rapidly in a remarkably short period of time and has even signed a contract to export nuclear plants to the UAE.

  - In December 2009 a reported $20 billion contract with the United Arab Emirates (UAE) for building four 1.4GW reactors

Challenges

- Strong illusion about nuclear power
- Excessive confidence in economic growth
- bird in a cage of economic growth.
- Energy policy of encouraging electricity consumption
- Energy policy to technological development of new energy on supply-side
- Social consensus on nuclear energy and safety standards
- Restructuring of electricity industry toward decentralized system

Thank You!

leemcho@naver.com