Korea's Energy Security Perspective

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Disclaimer

I do not represent the Korean Government

(This material contains personal view)

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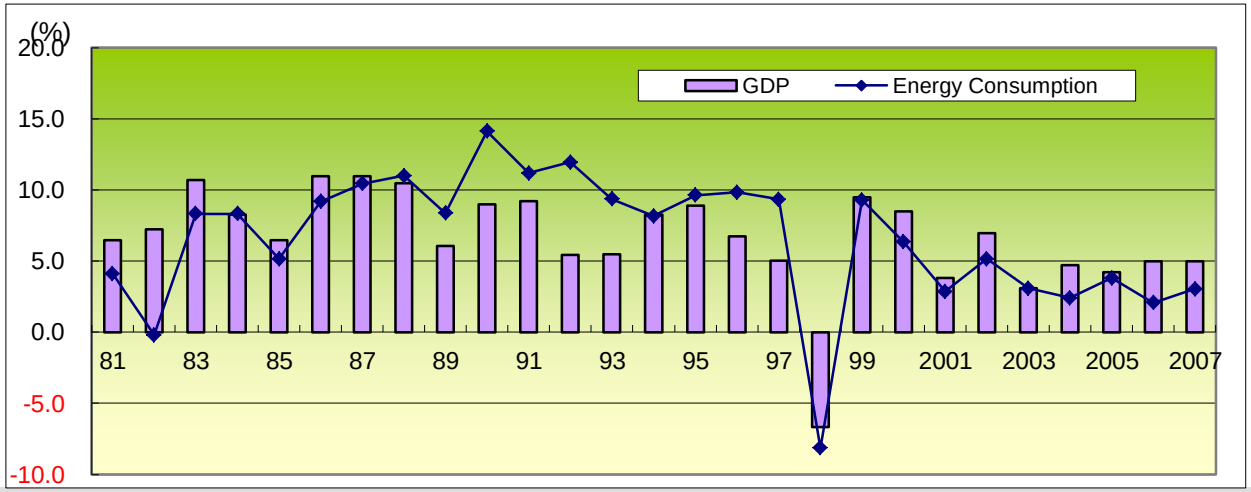
I. Energy Situation

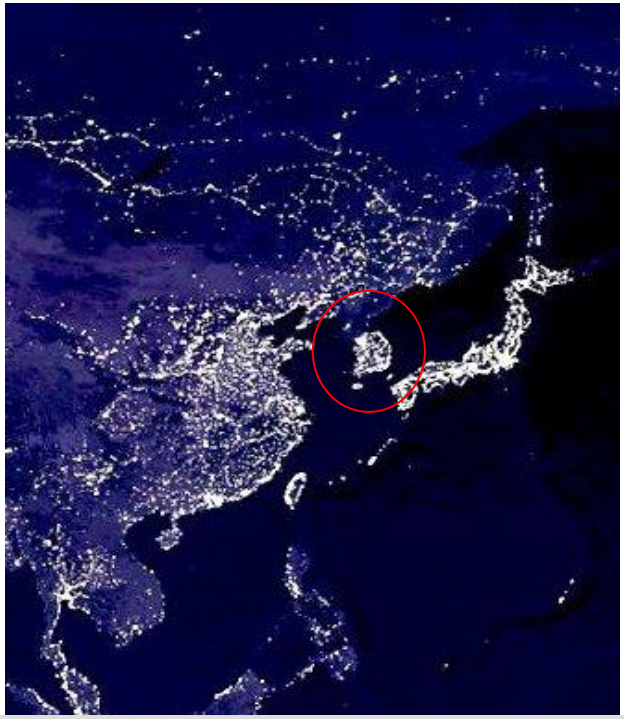
Introduction of Economy, Energy Sector

- Rapid and Continuous Economic Growth
  - Industry, Commercial, Transport sectors have been growing fast
  - Slow population growth
- Structure of Energy Sector
  - Vast majority of energy imported
    - Petroleum, LNG, Coal
  - Electricity generation :
    - Nuclear, Imported coal, Natural gas, small amount of hydro, declining amount of oil

1987 – 1997 : Avg. increase rate/year
- **Energy consumption : 10.3%**
- **GDP : 7.7%**

1998 – 2007 : Avg. increase rate/year
- **Energy consumption : 4.2%**
- **GDP : 5.6%**

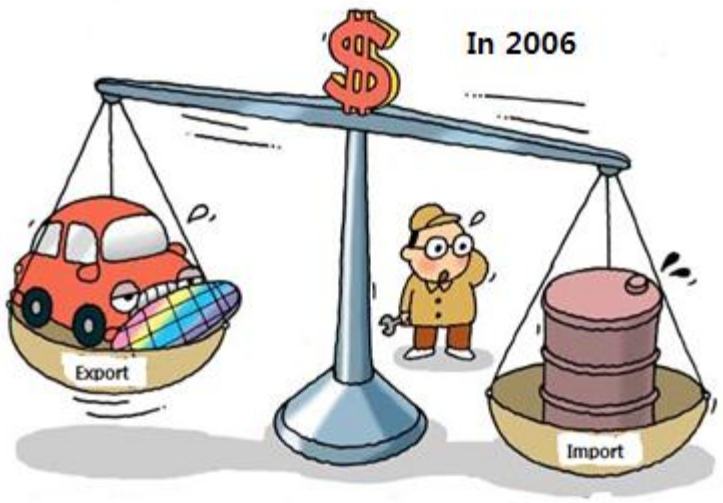




Overview

- Korea imports 97% of energy from overseas
  - 5th largest importer of oil in the world
    - Relies on imports for all of its oil needs
  - 2nd largest importer of both LNG and coal

- Korea is very vulnerable to external market conditions

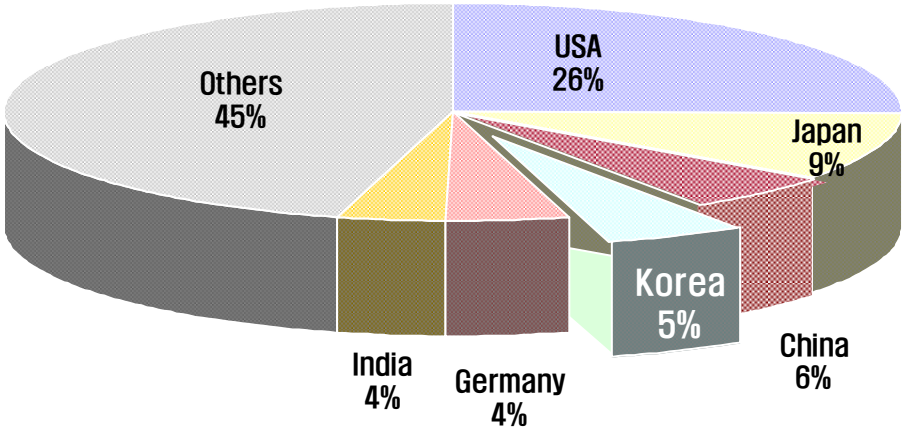


Top ten energy consumers in the world

Rank	Energy consumption	Oil consumption
1	USA	USA
2	China	China
3	Russia	Japan
4	Japan	Russia
5	India	Germany
6	Germany	India
7	Canada	Korea
8	France	Canada
9	UK	Mexico
10	Korea	France

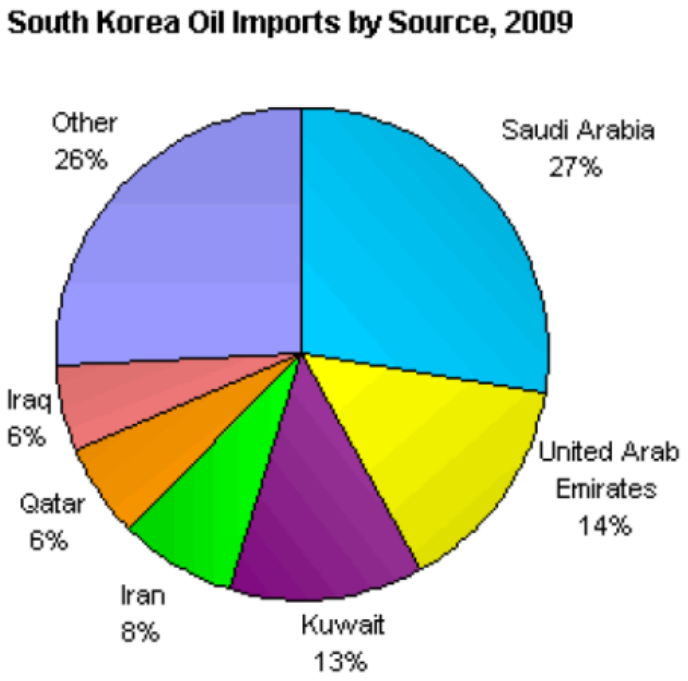
- **Total amount of Oil imported in 2008 :**

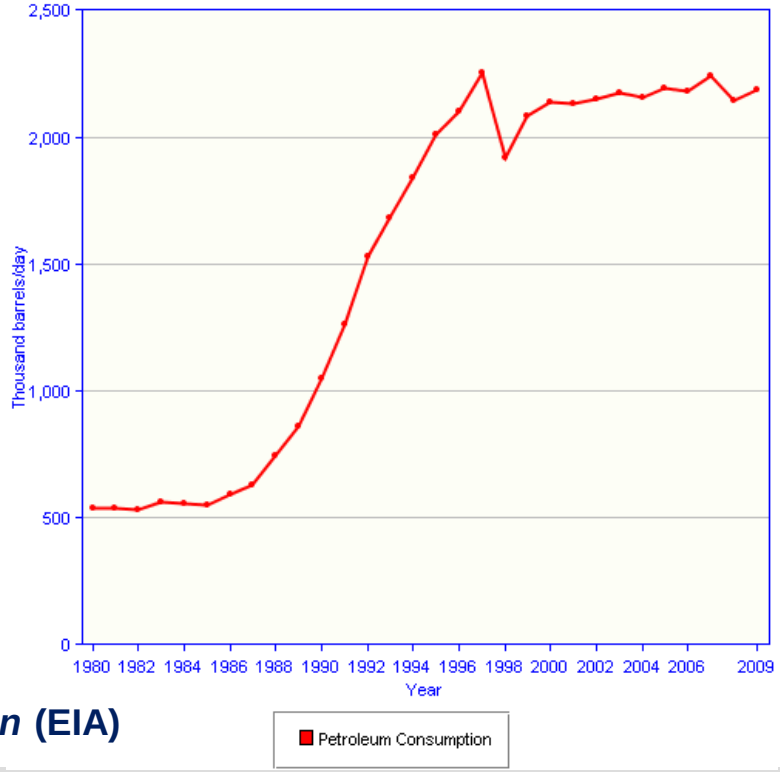
85.86 billion US $



Oil

- No domestic crude oil production
  - Completely dependent on imports
- Heavy dependence on the Middle Eastern oil
  - Middle East 73.4%; South east Asia 17.3%; Africa 4.5%; Etc.4.8%
- Industrial Sector : more than half of end-use consumption
- Re-exports 25% gross oil imports as refined petroleum products

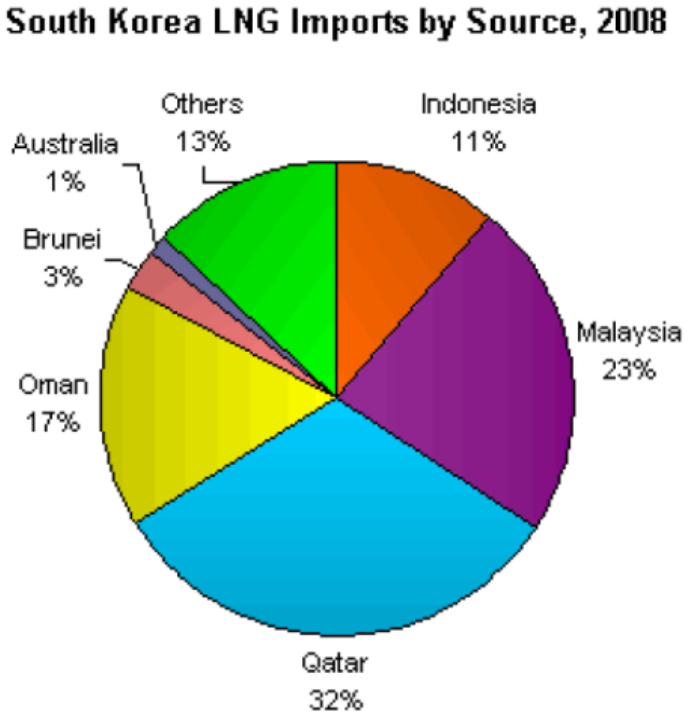


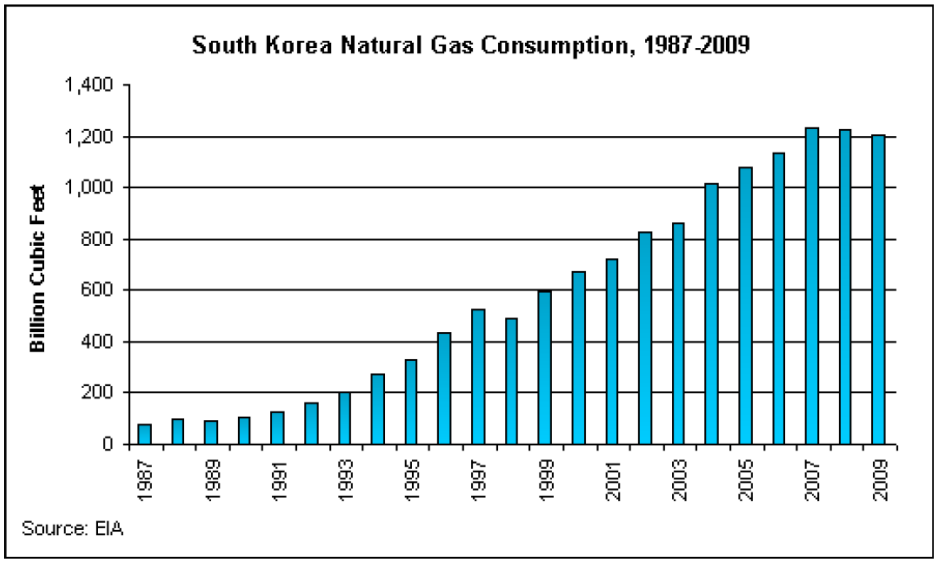


Source : U.S. *Energy Information Administration* (EIA)

Natural Gas

- Major purchaser of LNG (2nd in the world)
- Qatar, Indonesia, Malaysia, Oman are the major sources of import
- City gas networks : 64%
  - Residential, commercial, industrial consumers
- Power generation : All of the remainder



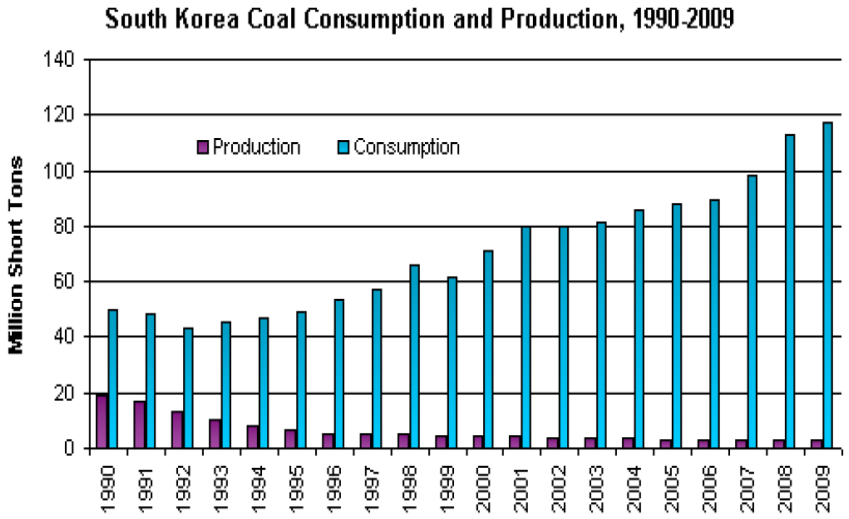


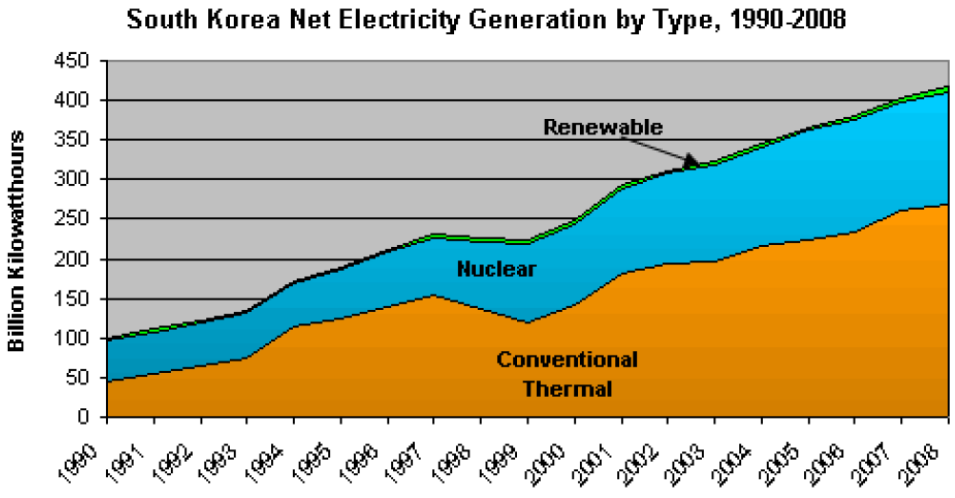
Source : U.S. EIA

Coal & Electricity Generation

- 2nd importer in the world
  - From Australia, Indonesia
- Electricity Sector : more than half of consumption
- Industrial Sector : most of the remainder

- Fossil fuels (coal, gas and oil)
  - Greatest share of electricity
- Nuclear power : more than one third
- Renewables : ~ 2%

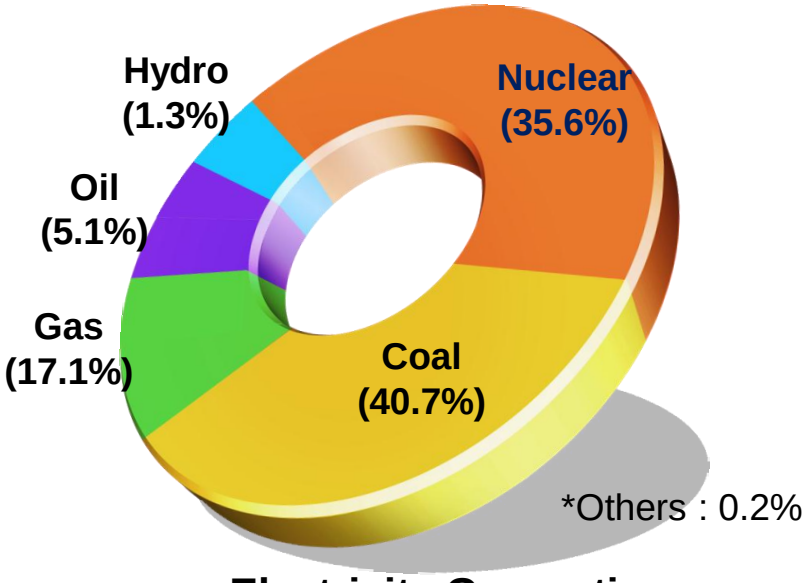




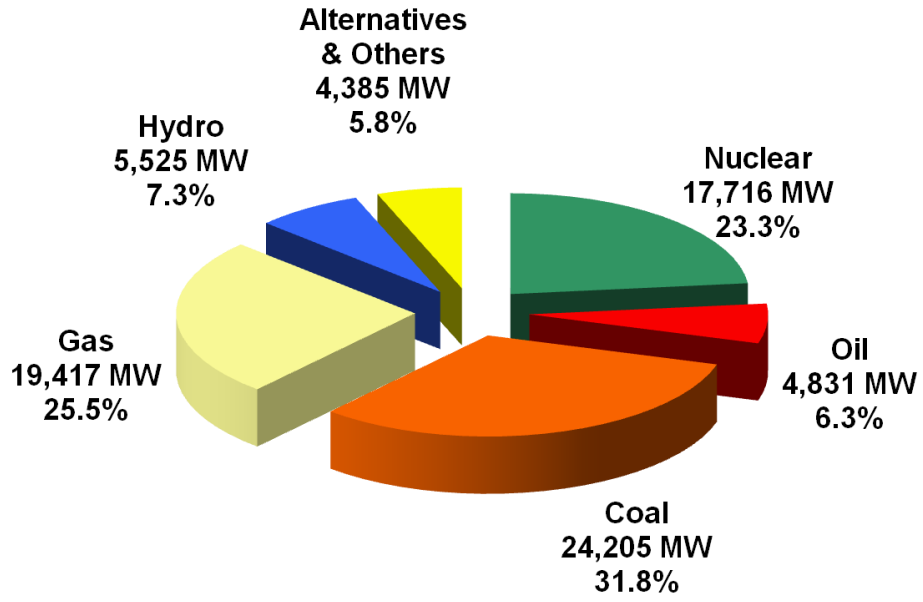
Source : U.S. EIA

Energy Supply Security

- Depending on the year, energy imports (excluding uranium)
  - some 15% to 20% of Korea's total imports
- Fuel import dependence, and hence vulnerability to fuel price volatility
  - has been reduced with the development of nuclear power.
- While energy fuel imports continue to rise as the economy expands,
  - the rate of increase is lessened by the extent of substitution of nuclear for fossil-based generation.



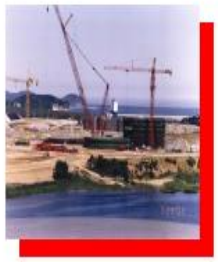
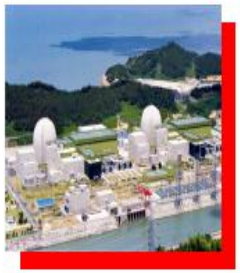
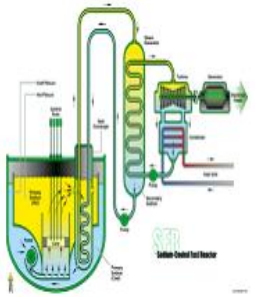
Electricity Generation



Total Installed Capacity

II. Status of Nuclear Power Plant

Nuclear Power Program of Korea

1970s	1980s	1990s	2000s	2010s	2020s
Introduction of Nuclear Power	Promotion of Localization	Technology Self-reliance	Development of Advanced Reactor	Improvement of Advanced Reactor	Development of Future Reactor
					
Construction of Kori #1 (`71-`78)	Establishment of Localization Plan (`84)	OPR1000 Development (`95)	APR1400 Development (`01)	APR1400+ SMART	Gen IV Systems (SFR, VHTR etc.)

* OPR1000 (Optimized Power Reactor 1,000) is new name for the former KSNP

Overview of Nuclear Power Plants

In Operation : 21 units
Under Construction : 5 units
Under Safety Review : 2 units

Ulchin
8 units

Wolsong
6 units

Low- and Intermediate- Level Waste Disposal Facility (Under construction)

Younggwang
6 units

Kori
8 units

In Operation
Under PSAR Review
Under Construction

Nuclear Power Plants in Operation

Nuclear Power Plants in Operation (as of March 25, 2011)

Commercial Operation	Plant	Reactor Type	Capacity (MWe)	Remarks
1978. 04	Kori Unit 1	PWR	587	21 units are in Operation (18,716MWe)
1983. 04	Wolsong Unit 1	PHWR	679	
1983. 07	Kori Unit 2	PWR	650	
1985. 09	Kori Unit 3	PWR	950	
1986. 04	Kori Unit 4	PWR	950	
1986. 08	Yonggwang Unit 1	PWR	950	
1987. 06	Yonggwang Unit 2	PWR	950	
1988. 09	Ulchin Unit 1	PWR	950	
1989. 09	Ulchin Unit 2	PWR	950	
1995. 03	Yonggwang Unit 3	PWR	1,000	
1996. 01	Yonggwang Unit 4	PWR	1,000	
1997. 07	Wolsong Unit 2	PHWR	700	
1998. 07	Wolsong Unit 3	PHWR	700	
1998. 08	Ulchin Unit 3	PWR (OPR 1000)	1,000	
1999. 10	Wolsong Unit 4	PHWR	700	
1999. 12	Ulchin Unit 4	PWR (OPR 1000)	1,000	
2002. 05	Yonggwang Unit 5	PWR (OPR 1000)	1,000	
2002. 12	Yonggwang Unit 6	PWR (OPR 1000)	1,000	
2004. 07	Ulchin Unit 5	PWR (OPR 1000)	1,000	
2005. 04	Ulchin Unit 6	PWR (OPR 1000)	1,000	
2011. 02	Shin-Kori 1	PWR (OPR 1000)	1,000	

NPPs Under Construction and Planned

Nuclear Power Plants under construction and planned (as of March 25, 2011)

Completion of Construction	Plant	Reactor Type	Capacity (MWe)	Remarks
2011.12	Shin-Kori Unit 2	PWR (OPR 1000)	1,000	5 units are under construction (5,800MWe)
2012.03	Shin-Wolsong Unit 1	PWR (OPR 1000)	1,000	
2013.01	Shin-Wolsong Unit 2	PWR (OPR 1000)	1,000	
2013.09	Shin-Kori Unit 3	PWR (APR 1400)	1,400	
2014.09	Shin-Kori Unit 4	PWR (APR 1400)	1,400	
2015.12	Shin-Ulchin Unit 1	PWR (APR 1400)	1,400	Under Safety Review for CP
2016.12	Shin-Ulchin Unit 2	PWR (APR 1400)	1,400	
2018.12	Shin-Kori Unit 5	PWR (APR 1400)	1,400	Planned
2019.12	Shin-Kori Unit 6	PWR (APR 1400)	1,400	
2020.06	Shin-Ulchin Unit 3	PWR (APR 1400)	1,400	
2021.06	Shin-Ulchin Unit 4	PWR (APR 1400)	1,400	

Note : 1) OPR 1000 : Optimized Power Reactor (PWR type)
2) APR 1400 : Advanced Power Reactor (PWR type)

NPPs under Construction & Safety Review (CP)

Shin-Kori 2

Shin-Wolsong 1&2

Shin-Kori 3&4

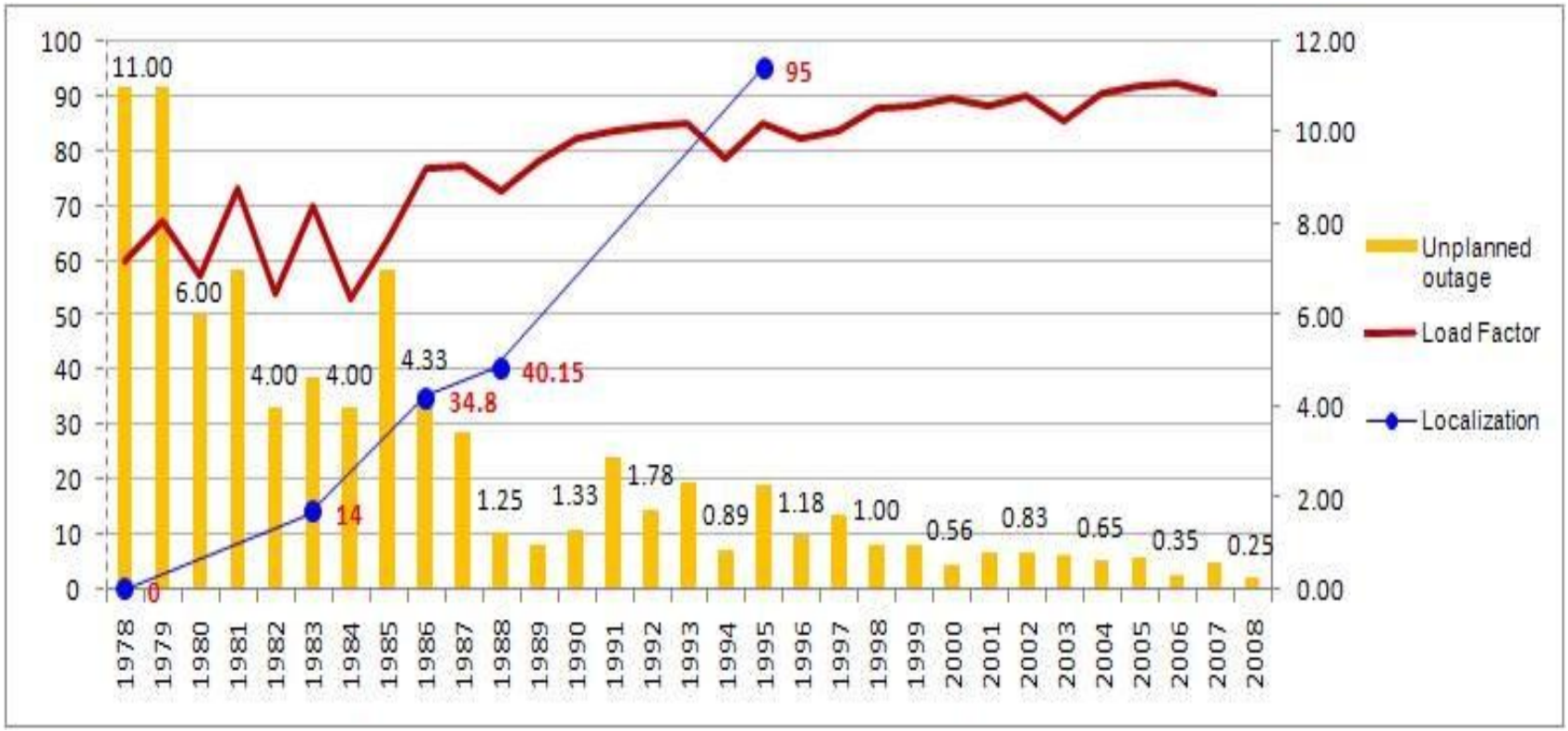
Shin-Ulchin 1&2

Technology localization and operation records

- Increasing localization of NPP leads high load factor and low unplanned outage

* Load factor : average power divided by the peak power over a period of time

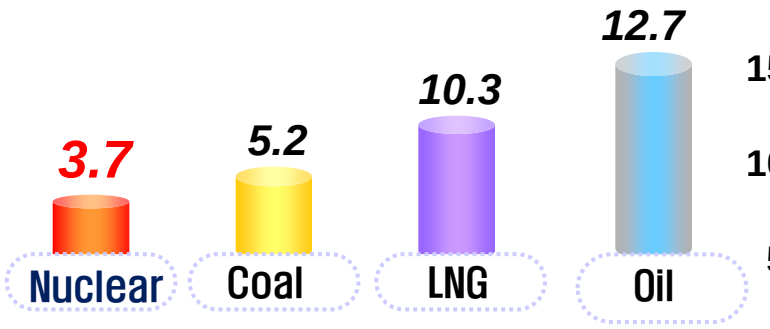
- High load factor leads to low generation cost
- Aiming at 100% localization of APR 1400 by 2012

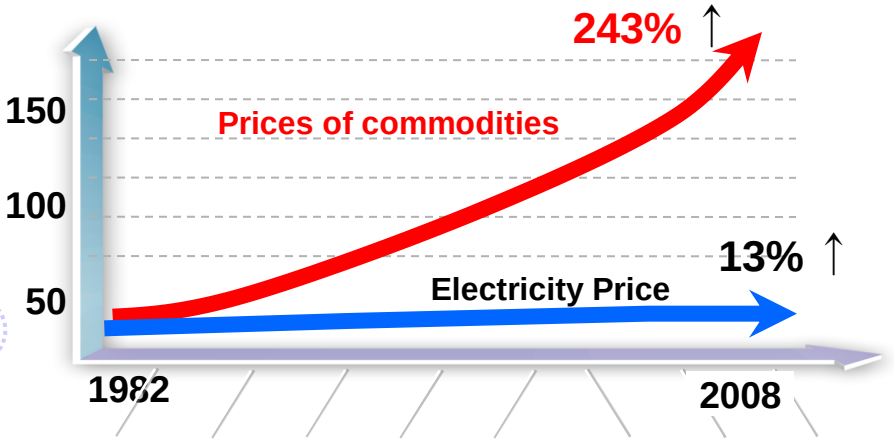


Electricity Price Aspect

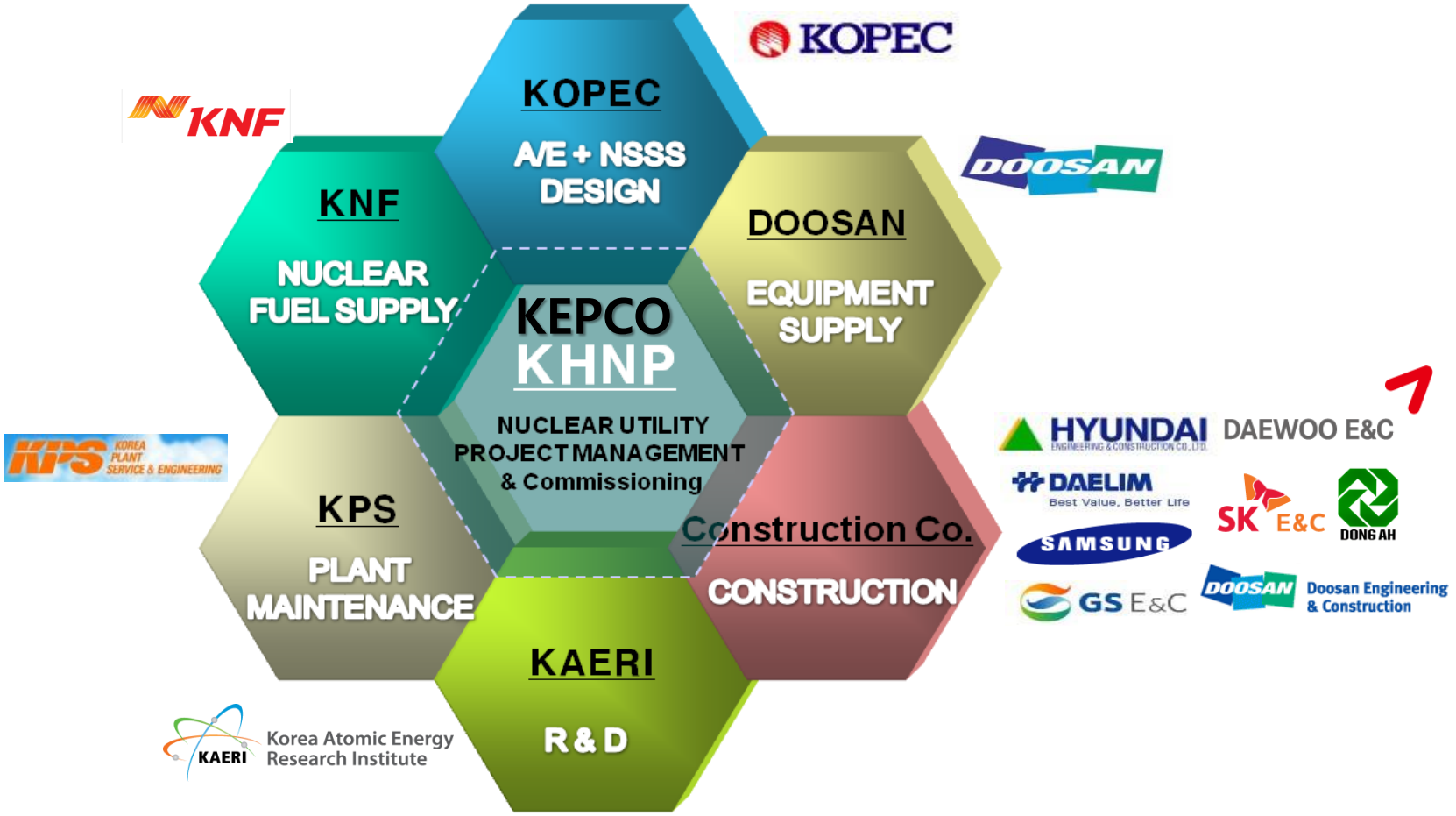
Nuclear energy is the most economical resource with the lowest electricity generation cost in Korea

Sales price (’09. 12, cent/kWh)





Key Players of Nuclear Industry



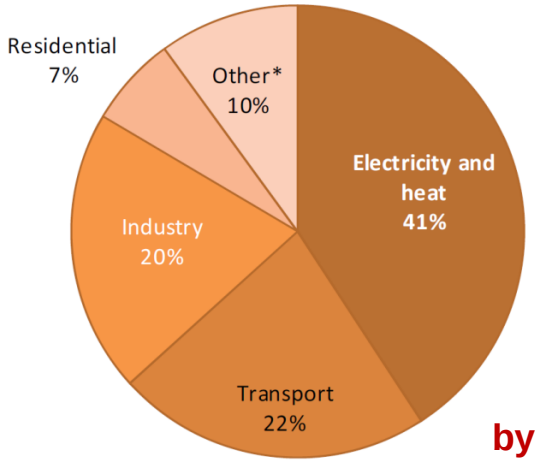
III. Climate Change & Low Carbon Green Growth Policy

Global Warming

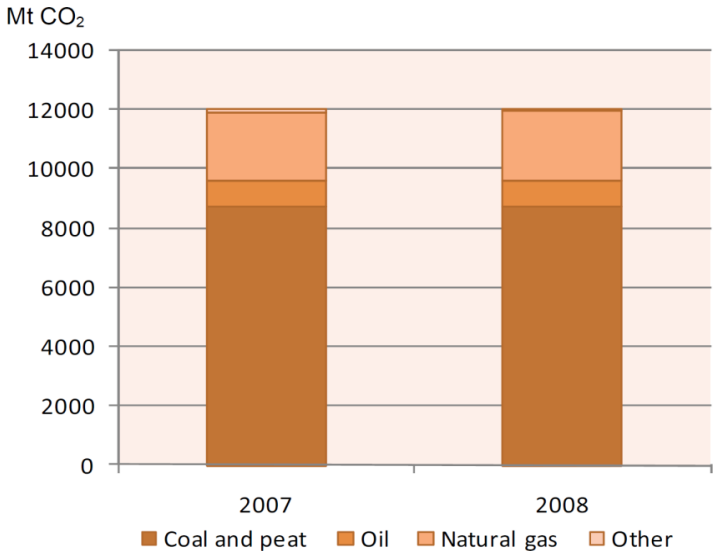
- For example, Korea
  - Average temp. has risen faster in Korea, increasing 1.0% over the past 90 years, since the country began meteorological surveys in 1904.
- One of the major reasons for global warming is the greenhouse effect, which is caused by the accumulation of emissions from the burning of fossil fuels.
- A growing chorus of voices is calling for a shift of the fossil fuel dependent energy paradigm in order for the world to resolve the issue of global warming.

World CO_2 emissions in 2008

- Two sectors, electricity and heat generation and transport,
  - produced two-thirds of global CO_2 emissions in 2008
- Electricity and heat generation sector
  - was the largest producer of CO_2 emissions
  - was responsible for 41% of the world CO_2 emissions
  - Worldwide, this sector relies heavily on fossil fuels.
  - CO_2 emission
    - Coal > Natural gas > Oil > Others



by sector



CO2 emissions from electricity and heat generation

Source : **CO_2 Emissions from Fuel Combustion, International Energy Agency, 2010 Edition**

Kyoto Protocol

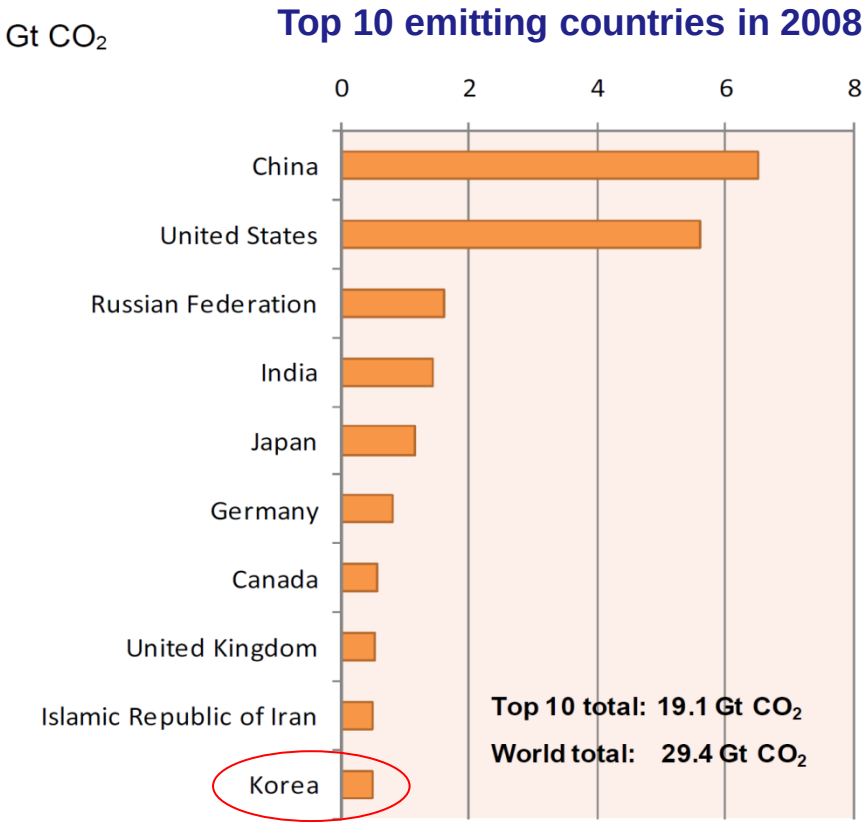
- UNFCCC (United Nations Framework Convention on Climate Change)
  - An international environmental treaty with the goal of achieving the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.“
- Kyoto Protocol
  - A protocol to the (UNFCCC or FCCC), aimed at fighting global warming.
  - Initially adopted on 11 December 1997 in Kyoto, Japan, and entered into force on 16 February 2005.
  - As of August 2011, 191 states have signed and ratified the protocol.
- Annex I countries agreed to reduce their collective greenhouse gas emissions by average 5.2% from the 1990 level.

Situation of Korea

- Korea
  - Currently not under the Annex I
  - Pressures to join in the regime are growing.
- Climate change is another big challenge for Korea's energy security.
  - very vulnerable to GHG reduction due to its industrial structure

A steel factory at night in Pohang in Korea

Top 10 emitting countries account for about two-thirds of the world CO_2 emissions



Source : **CO2 Emissions from Fuel Combustion, International Energy Agency, 2010 Edition**

Korean Government's New Vision for ‘Green Growth’

- On 15 August 2008, commemorating the 60th anniversary of the country's foundation, President Lee Myung-bak proclaimed
  - “Low Carbon Green Growth” as “a new national development paradigm that creates new growth engines and jobs with green technology and clean energy”.

Implementation of Green Growth in Energy Sector

- On 27 August 2008, National Energy Committee, presided by the President, announced the first *Basic Plan on National Energy (2008-2030).*
  - Determined the direction of national energy policy until 2030
  - Mapped out the plan on the basis of the 3Es

- Korea will reach its long-term energy goals by taking the following steps
  - *Improving energy efficiency and reducing energy consumption*
  - Increasing the supply of clean energy and reducing the use of fossil fuels
    - Nuclear power generation : 36%(in 2009) → 59% by 2030.
    - 21 NPPs (in 2011) → 40 NPPs in 2030.
    - Renewable energy target: 2.37% → 11% by 2030
  - *Boosting the green energy industry*
  - *Ensuring its citizens have access to an affordable energy*

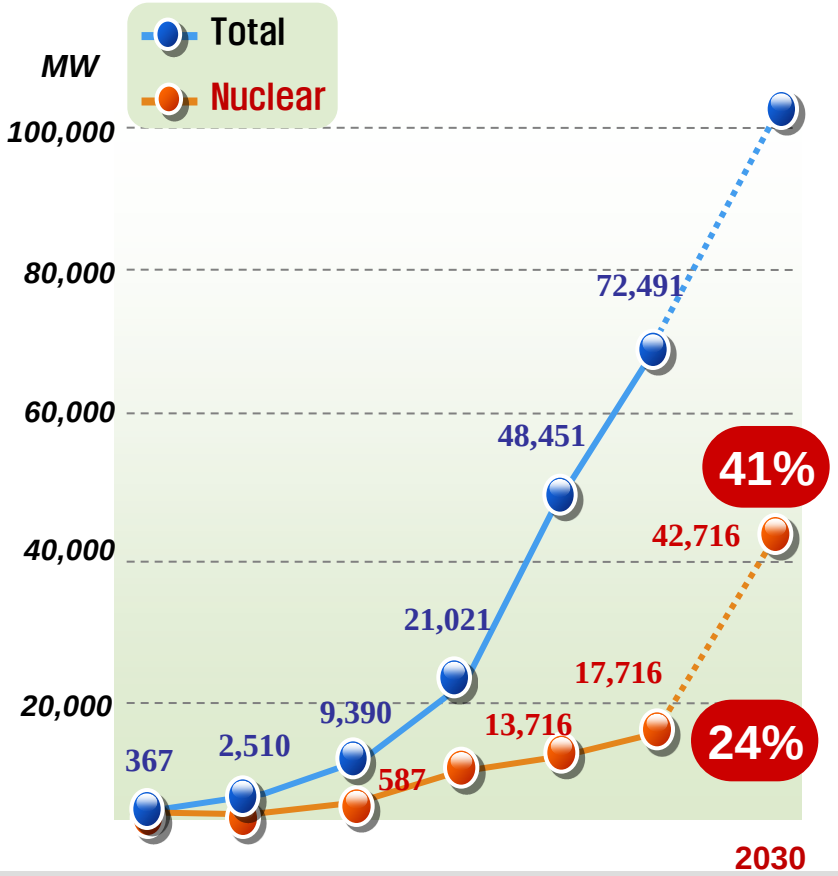
Nuclear power will be a driving force of Green Growth policy

National Nuclear Energy Development Plan

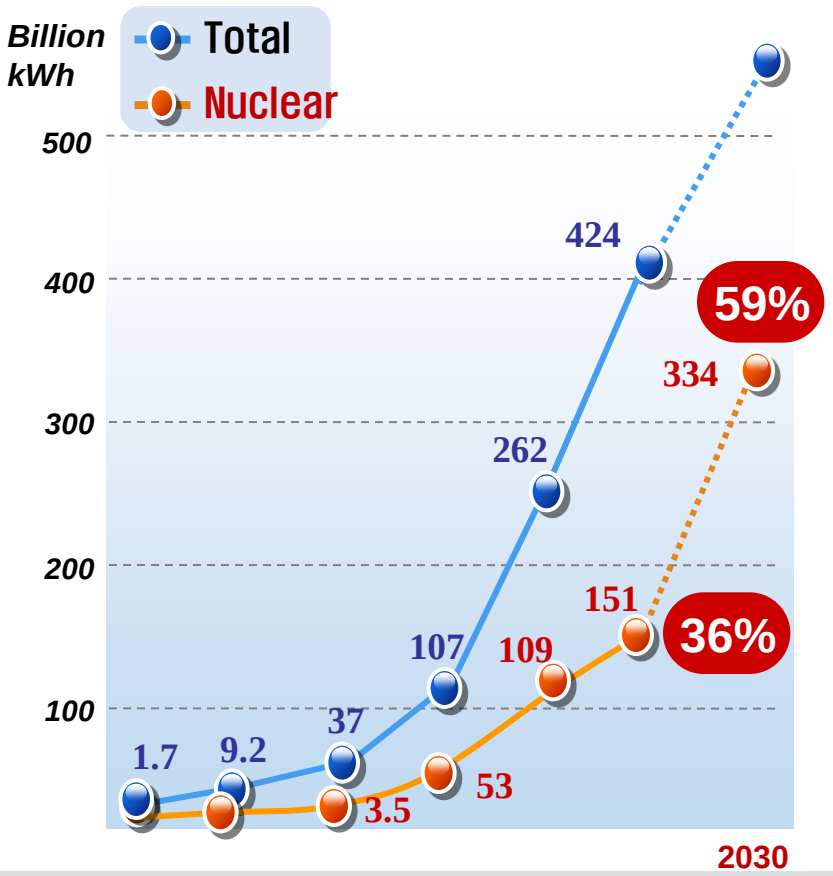
Electricity generation will be increased up to 59% by 2030

21 nuclear units in operation(2011), 40 nuclear units by 2030

Installed Capacity



Electricity Generation



IV. Look Back & Look Forward

Look Back : NP Strengthened Energy Security in Korea

- **Import Vulnerability**
  - Supply diversity is a key strategy for reducing vulnerability.

  ➡ NP increased the diversity of energy supply

- **Price Volatility**
  - Price of fossil fuels is volatile, and changes very quickly.
  - Nuclear electricity generating costs are less sensitive to changes in fuel prices than fossil fired generation.

  ➡ NP made electricity price structure less exposed to the ups and downs of international energy commodity markets.

- **Competitive Efficiency**
  - NP has maintained a steady share (~40%) of electricity generation
  - Average NP capacity factor in the last ten years was 90.2%
  - Unplanned capacity loss (0.5%) is the best in the world.
  - NPPs operate in a base load configuration at full power

  ➡ NP is competitive with fossil fuel fired plants.

NP has been a fairly controllable option for energy security in Korea

Look Forward : At UN, President Lee urges nuclear energy

- President Lee Myung-bak delivered a keynote speech to a high-level UN meeting on nuclear safety and security on 22 Sept. 2011

➡ His speech represents the energy policy for the future in Korea

[Quotation from Newspapers]

- "I do not think that the accident at Fukushima Daiichi NPP should be cause to renounce nuclear energy; on the contrary, this is a moment to seek ways to promote the safe use of nuclear energy based on scientific evidence."
- While nuclear energy is not the only way to solve the rapidly growing energy demands of the world, more efforts should be made to promote renewable energy, Lee said.

Look Forward : At UN, President Lee urges nuclear energy

- "Yet the use of nuclear energy is inevitable as there still remain technical and economic limits for alternative energy to meet the rapidly rising global energy demand or to tackle the problem of climate change," he said.
- Lee's remarks confirmed Korea's position that it will stick with its policy of nuclear energy expansion.
- Lee's "**low-carbon, green-growth**" vision largely centers on the use of nuclear energy.
- Calling nuclear energy "an inexpensive and clean energy source," Lee said it could be used more widely when its safety is guaranteed.

Value Beyond Energy

- Notably, nuclear energy is the alternative energy source
  - Can reduce the consumption of fossil fuels or replace them,
  - Can generate minimal greenhouse gases, and
  - Can provide massive volumes of reliable electricity.
- Unless there is an alternative source of massive volumes of energy, Korea has no choice but to depend on nuclear energy.
- This is not a matter of choice but a matter of survival for the development of Korea.

Thank you for your attention!

Terima Kasih !

Gam Sa Ham Ni Da!

KINS