

# Energy Industry Development Profiles in Korea

## Korean Energy Day

*The International Energy Forum and the Korean Embassy in Saudi Arabia*

**The Kingdom of Saudi Arabia**

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**Korea Energy Economics Institute**

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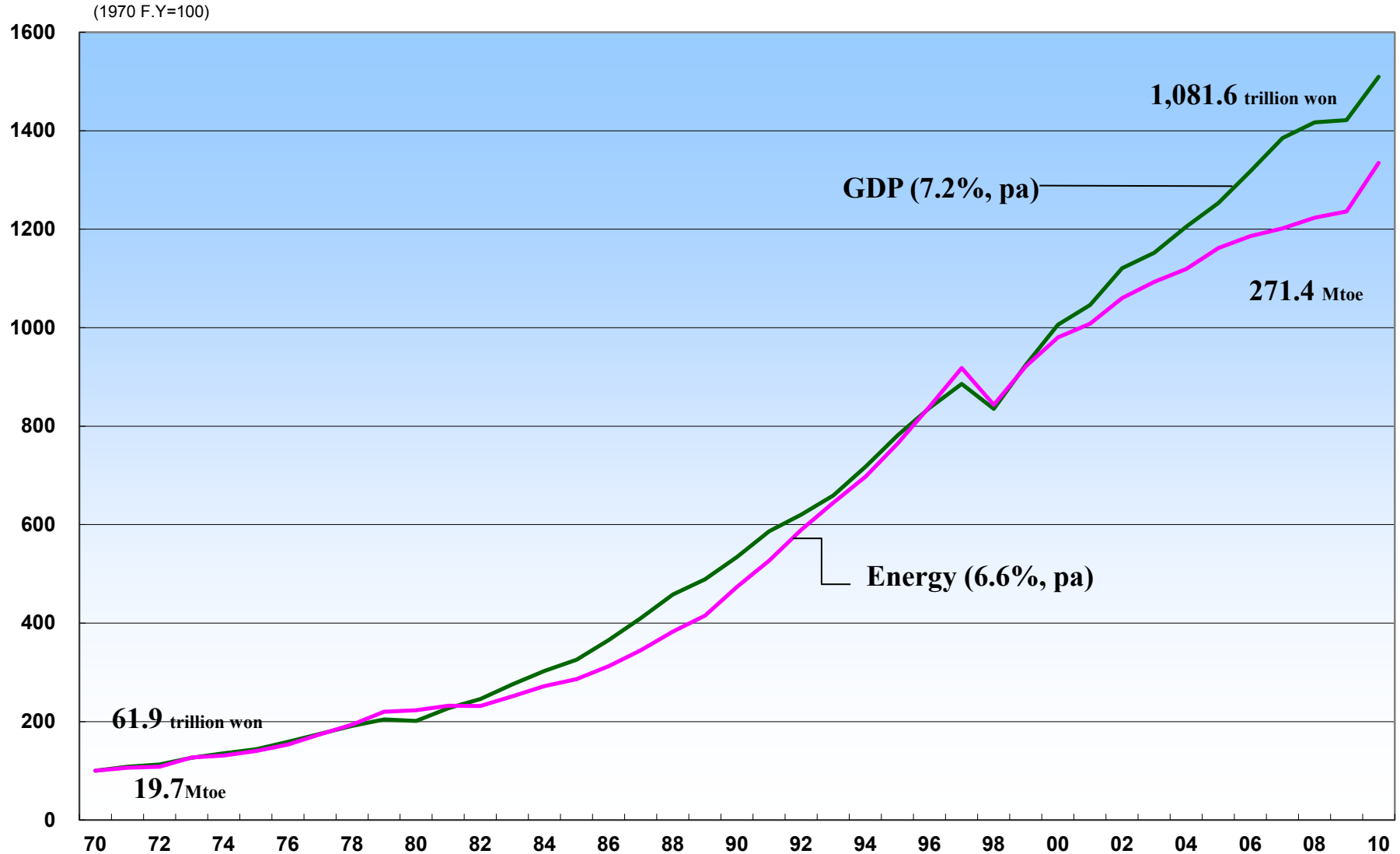
# Korea at a Glance

- **Land Area: 99,646 km<sup>2</sup>**
    - **More than 70 %: Unproductive hill/mountains**
  - **Population: 49.8 million**
    - **High population density**
    - **Skilled man powers**
  - **Moderate Climates**
    - **Cold winter: Low productivity in agricultures**
- ⇒ **Economic Development Strategy:**
- **High value-added industries**
  - **Export to international markets**
- **GDP (2011)**
  - **per capita: US\$ 22,489**



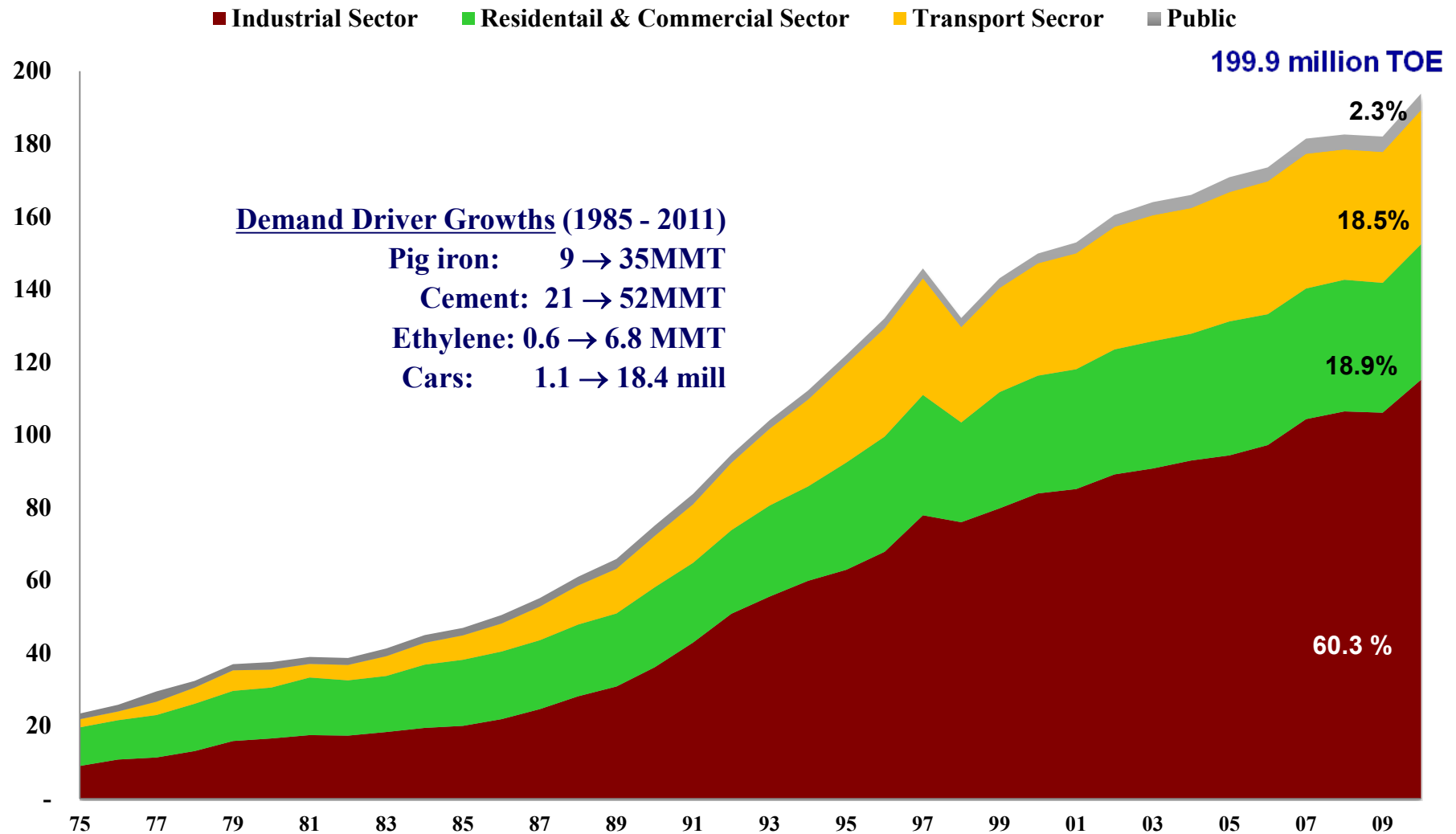


# Energy Demand and Economic Growth in Korea





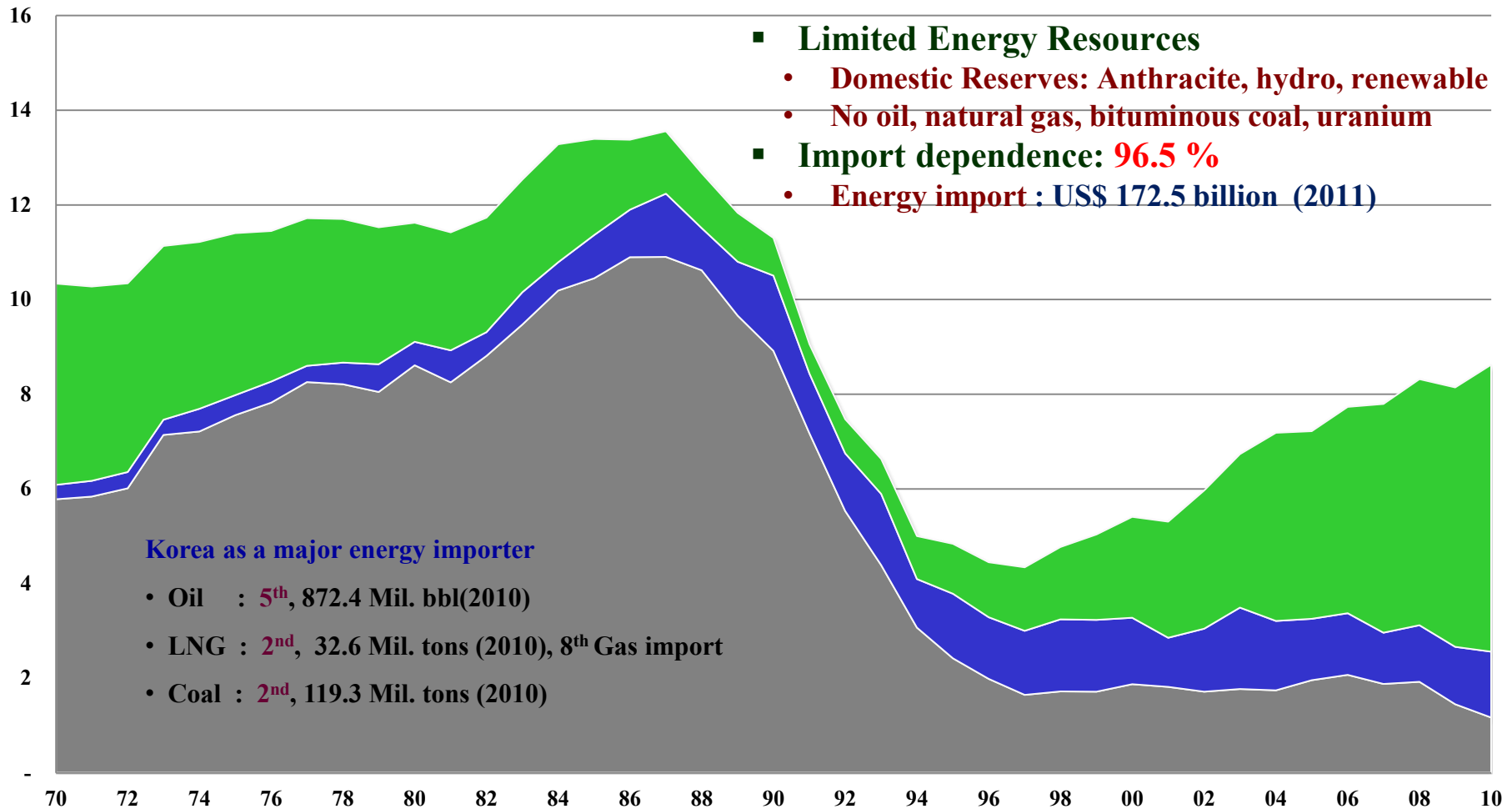
# Final Energy Demand by Sector in Korea



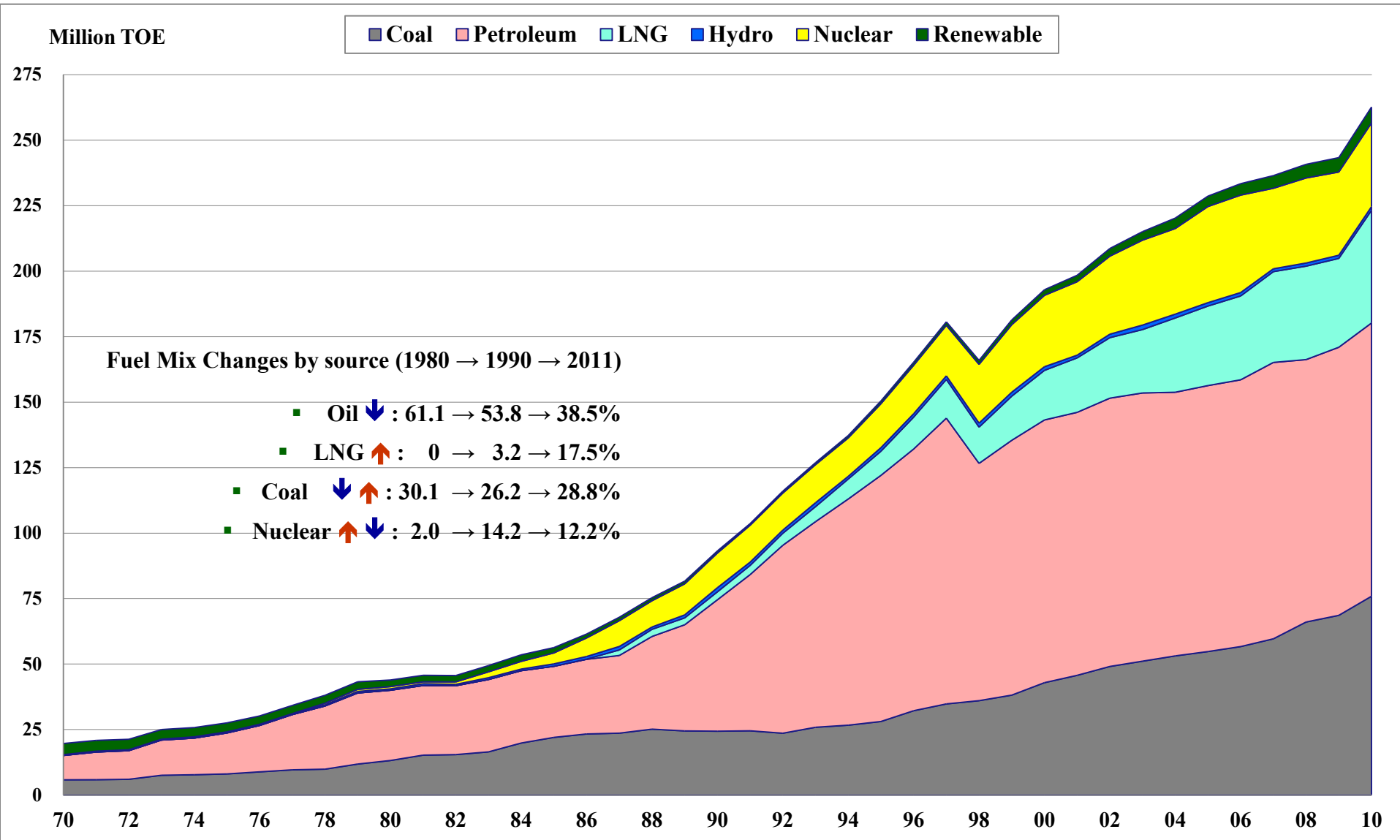
# Domestic Energy Production in Korea

Million TOE

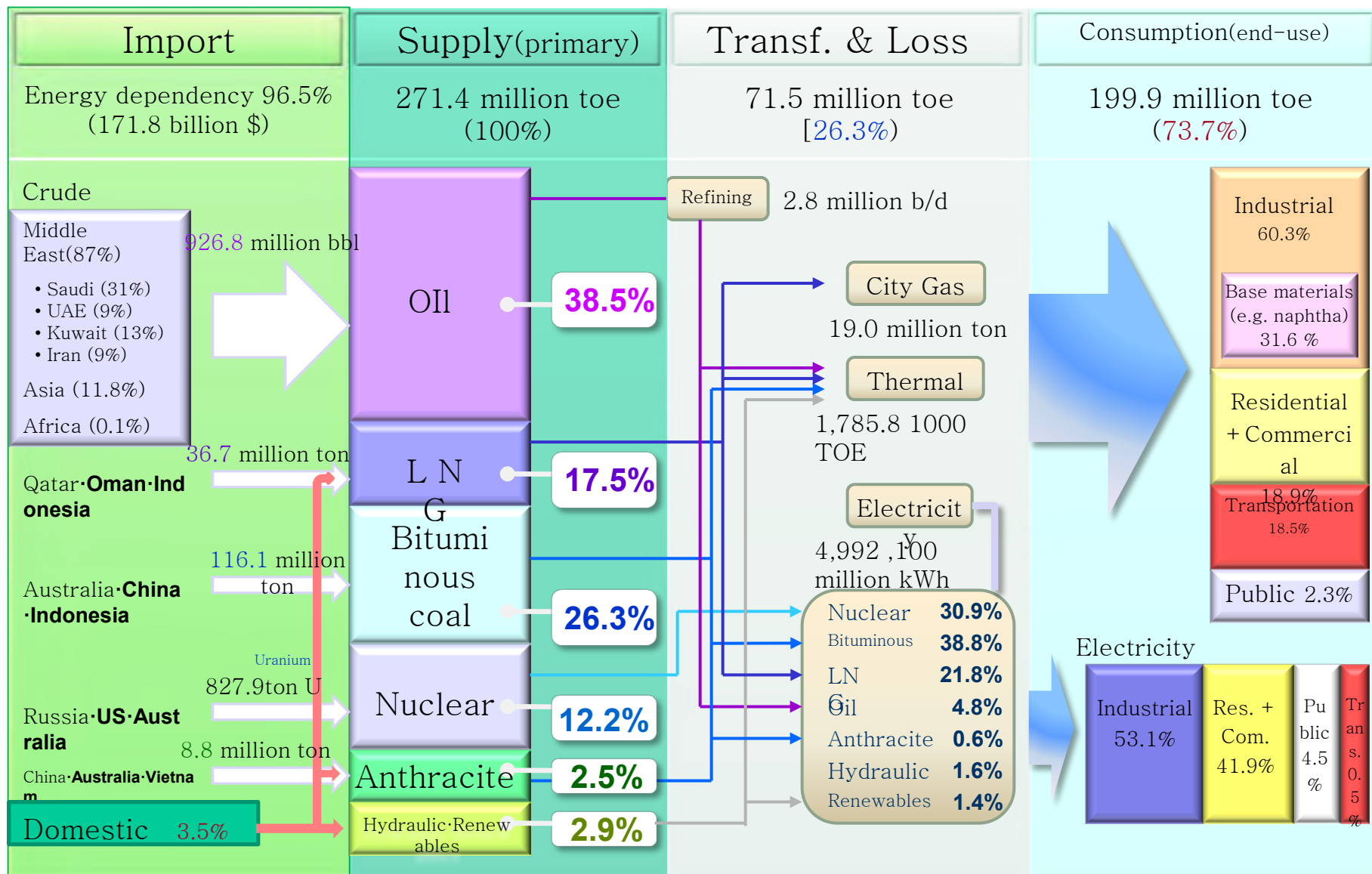
■ Coal ■ Hydro ■ Renewable



# Energy Mix Changes in Korea



# Energy Balance Flow in Korea (2011)





# Energy Development History in Korea

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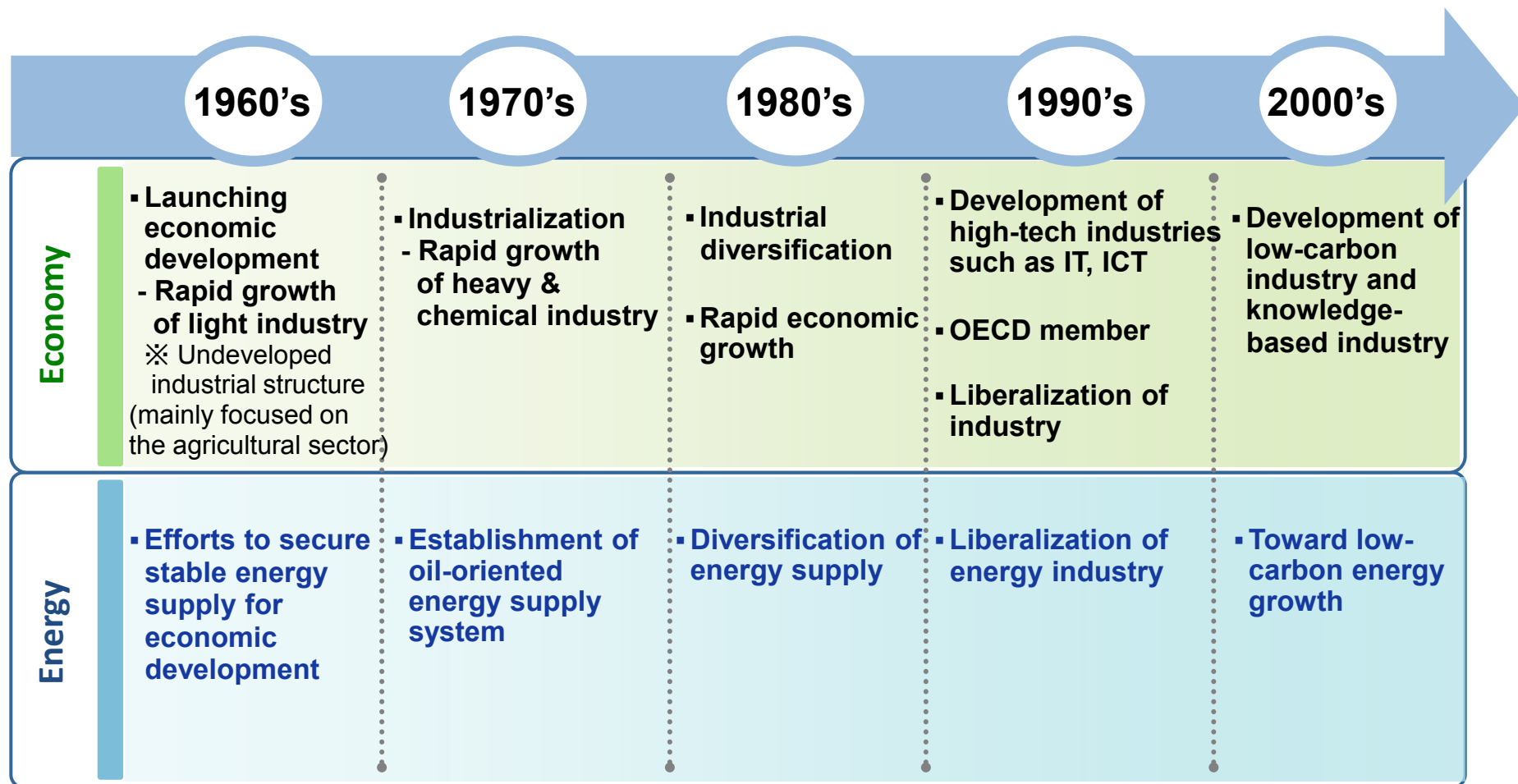
## ■ 1970 – 80's: Government Intervention

- *Petroleum Business Fund in 1980 → Energy-Resources Business Special Account in 1995.*
- **Fuel diversification away from oil**
  - Oil → Natural gas and nuclear,
- **High investment for energy facilities** (Refineries and power plants)

## ■ 1990 – 2000's: Network, Market Mechanism, Environment

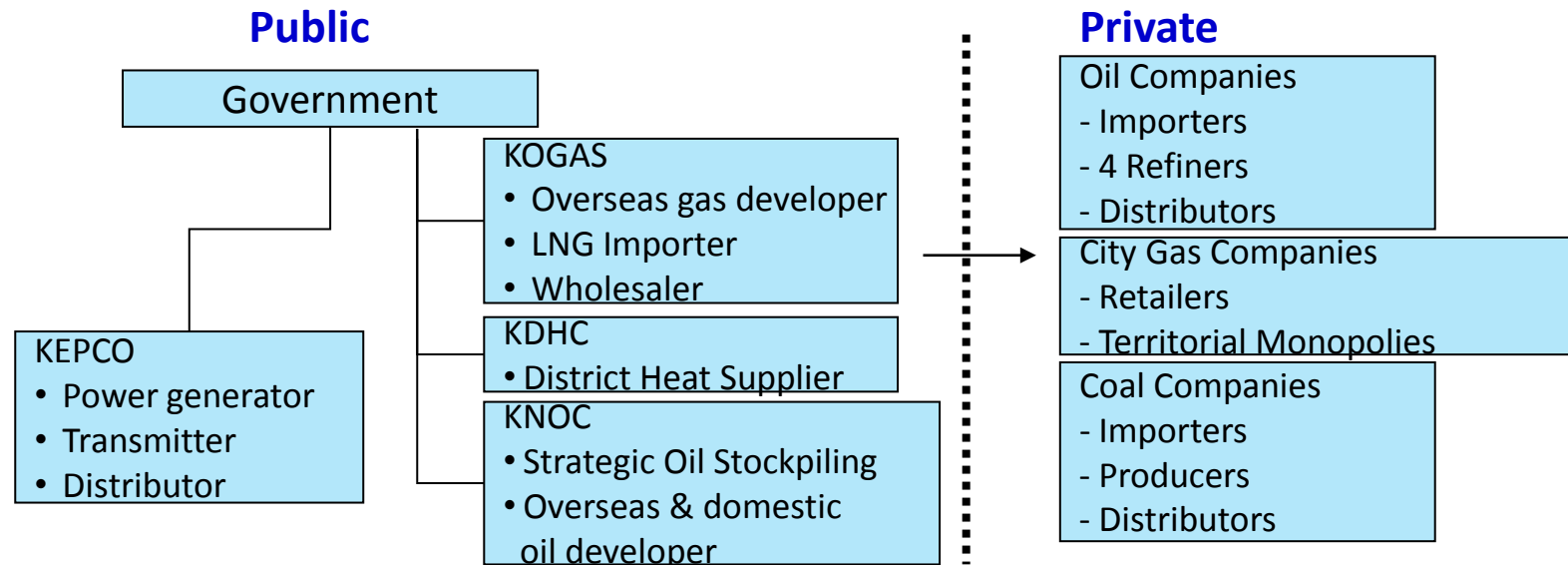
- **Modernization of energy infrastructure,**
  - Construction/expansion of nationwide natural gas and oil trunk pipeline systems
  - District heating/cooling system for household/commercial buildings
- **Strengthening the market mechanism,**
  - Petroleum prices were completely liberalized in 1997.
  - Energy security through improving market environment
- **Increased environmental concerns**
  - Energy conservation and efficiency improvement policies,
  - Renewable energy sources

# Overview of Korean Economy and Energy Sector Change



# Energy Industry Structure of Korea

- Promoting public companies and government-led development in the energy industry for a stable energy supply and active economic growth
- Supporting & controlling energy infrastructure with mid-to long-term plans
- Strengthening industrial competitiveness through liberalization of energy industry after the 1990s
  - Oil industry was successfully liberalized and opened
  - However, liberalization process of power industry and gas industry is still in progress



# Other Institutions for Energy in Korea

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## Institution

**Korea Energy Economics  
Institute (KEEI)**

**Korea Energy Management  
Corporation (KEMCO)**

**Korea Institute for Energy  
Research (KIER)**

## Function

**Energy Policy Planning and  
Research**

**Energy Audits & Implementation  
of Conservation Programs**

**Energy Technology Research**

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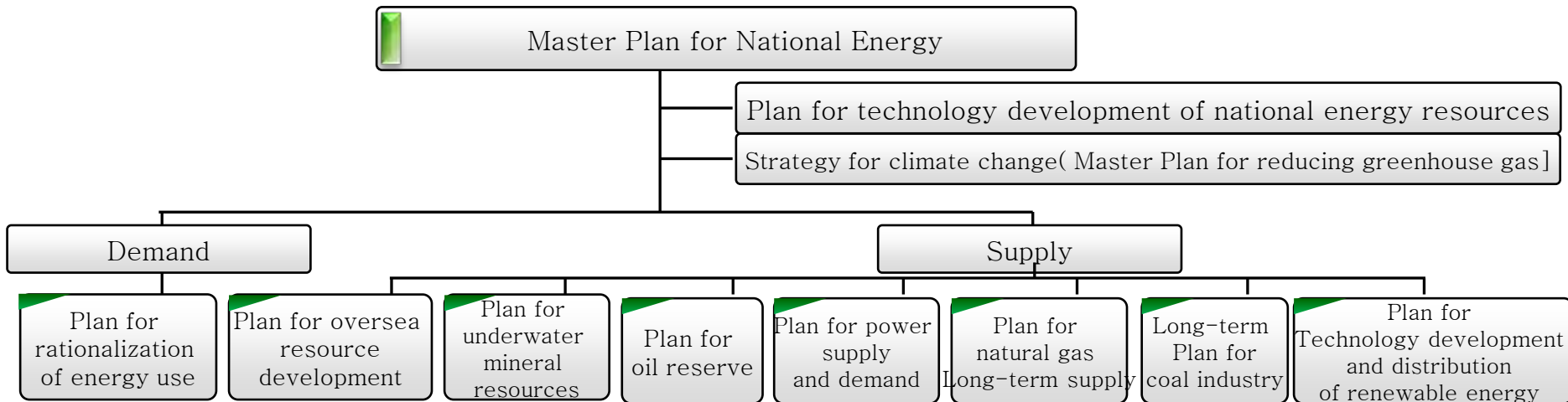
# Energy Planning in Korea

- Established 'Master Plan for National Energy' as top national strategy regarding energy policy since 1997

※ Master Plan for National Energy is the top energy plan which sets the basic direction and principle for mid- to long-term energy policy

- There are detailed plans for major energy sectors under the Master Plan for National Energy

## Structure of Energy Master Plan

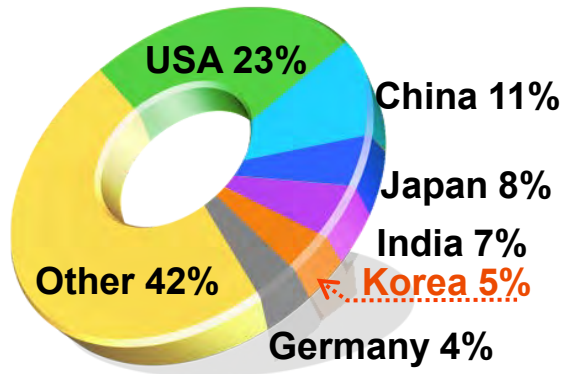


- All plans are mandated by laws.
- Responsible authority : Ministry of Knowledge Economy

# Oil Industry Development in Korea

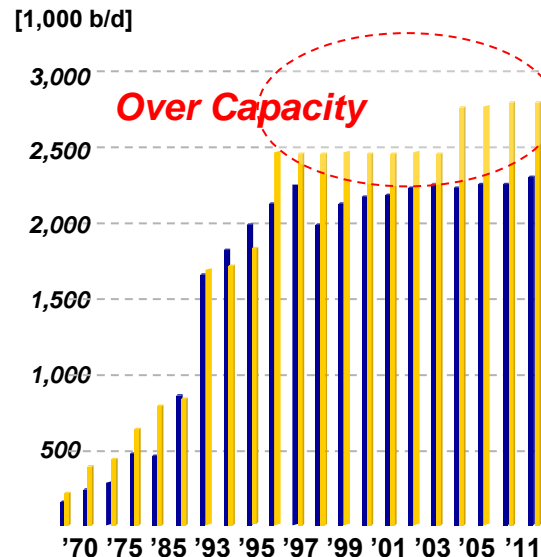
- The world's 5th largest crude oil importer
  - Total crude oil imports : 927 million barrels (2011)
- The world's 6th largest refinery capacity
  - Total refinery capacity : 2.78 million b/d (2011)
- Export of petroleum product recorded \$52 billion in 2011

World Crude Oil Import Share

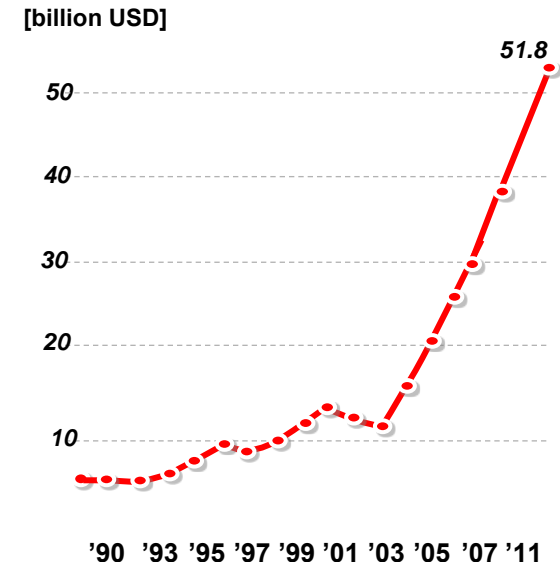


\* source : IEA/OECD (2012)

Demand vs. Capacity

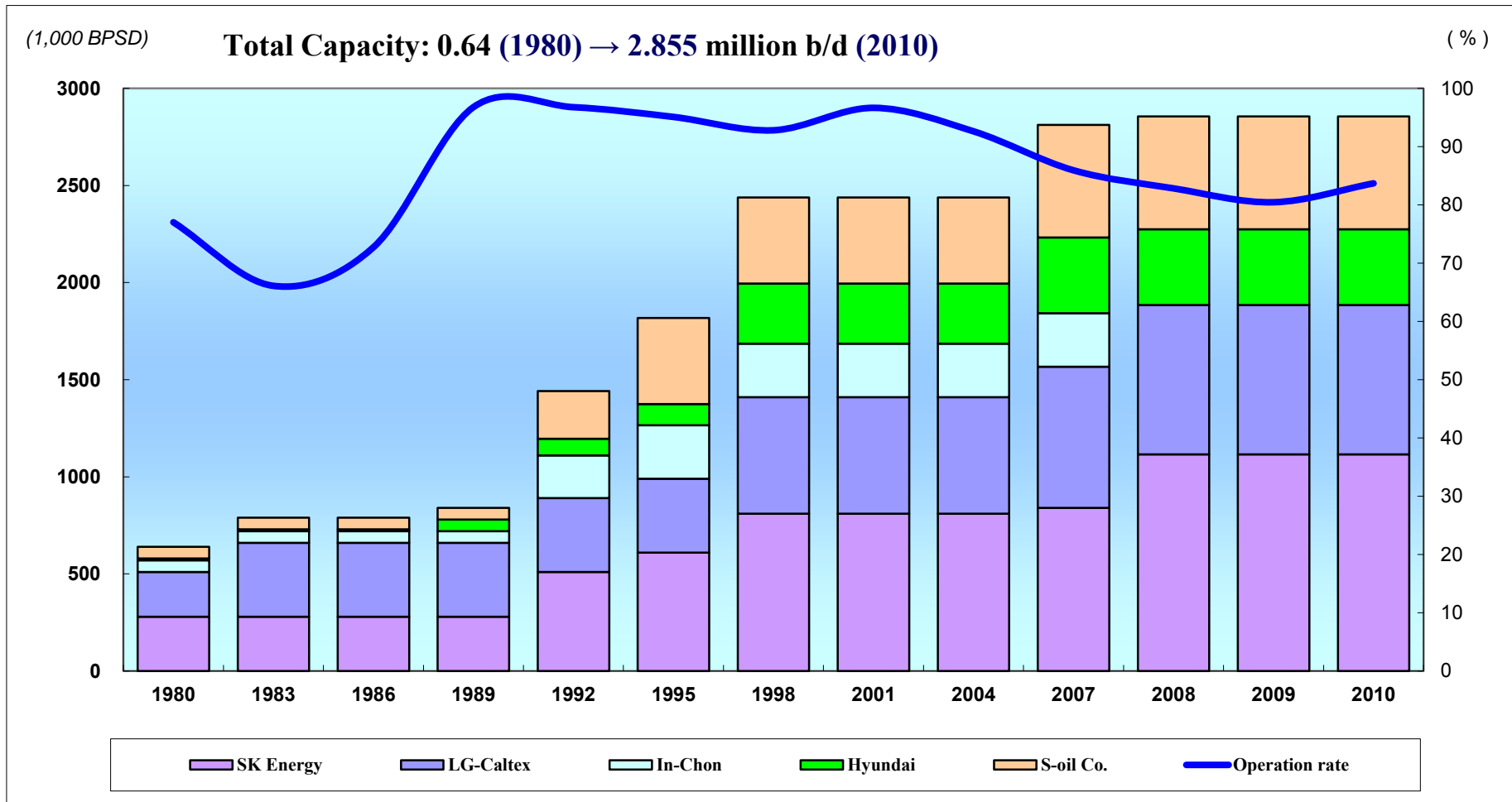


Petroleum Product Exports



# Oil Industry Development in Korea

- **Fully Privatization** : Entry, imports/export, and price linearization from 1997
- **4 Refiners**: SK (1,115 bpsd), GS-Caltex (770 bpsd), Hyundai (390 bpsd), S-oil (580 bpsd) + **Foreign participation**: Caltex, Aramco (Saudi)



# Oil Pipeline System in Korea

## Facilities Status

PIPELINE OPERATION > Facilities Status

### DOPCO Oil Pipeline Facilities Status (Network)



As the only company specializing in the construction and operation of oil pipelines, the DOPCO pipeline system connects refineries with major cities, airports, military bases and strategic petroleum storage terminals. This network ensures a safe and stable supply of petroleum to the nation.

The DOPCO pipeline network consists of 1,104KM of underground pipeline, 4 tank terminals with a 3,270Mbbbl storage capacity and 11 booster pump stations.

DOPCO has also operated the Trans Korea Pipeline (TKP) for USFK(US Forces Korea) since 1999.

Source: Daehan Oil Pipeline Corporation, Homepage: [www.DOPCO.co.kr](http://www.DOPCO.co.kr)

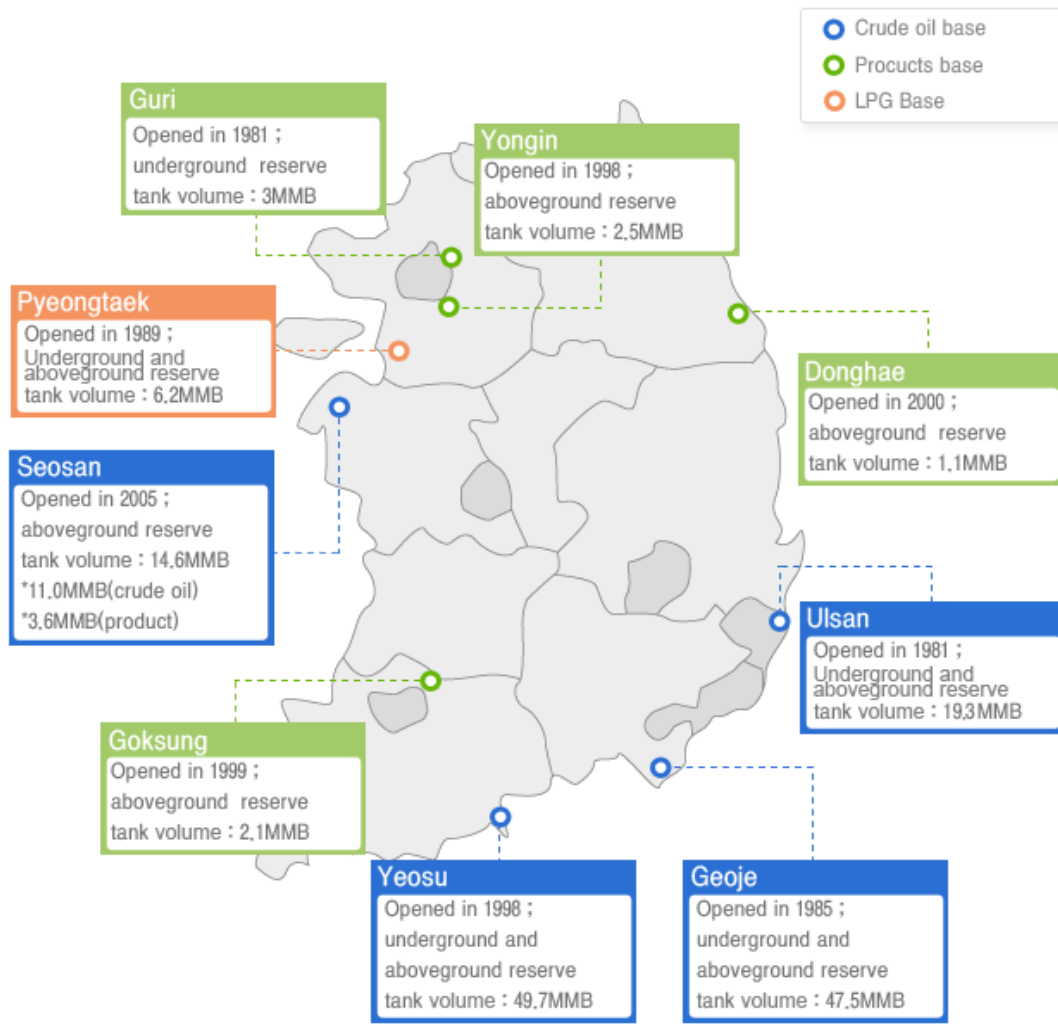


# Oil Stockpiling in Korea

**Nine stockpiling sites  
operated by the KNOC**

**Total capacity: 127MMB  
of reserves  $\Rightarrow$  141MMB  
by 2013**

**Duration day: 191 days  
(IEA standards (net daily  
imports))**

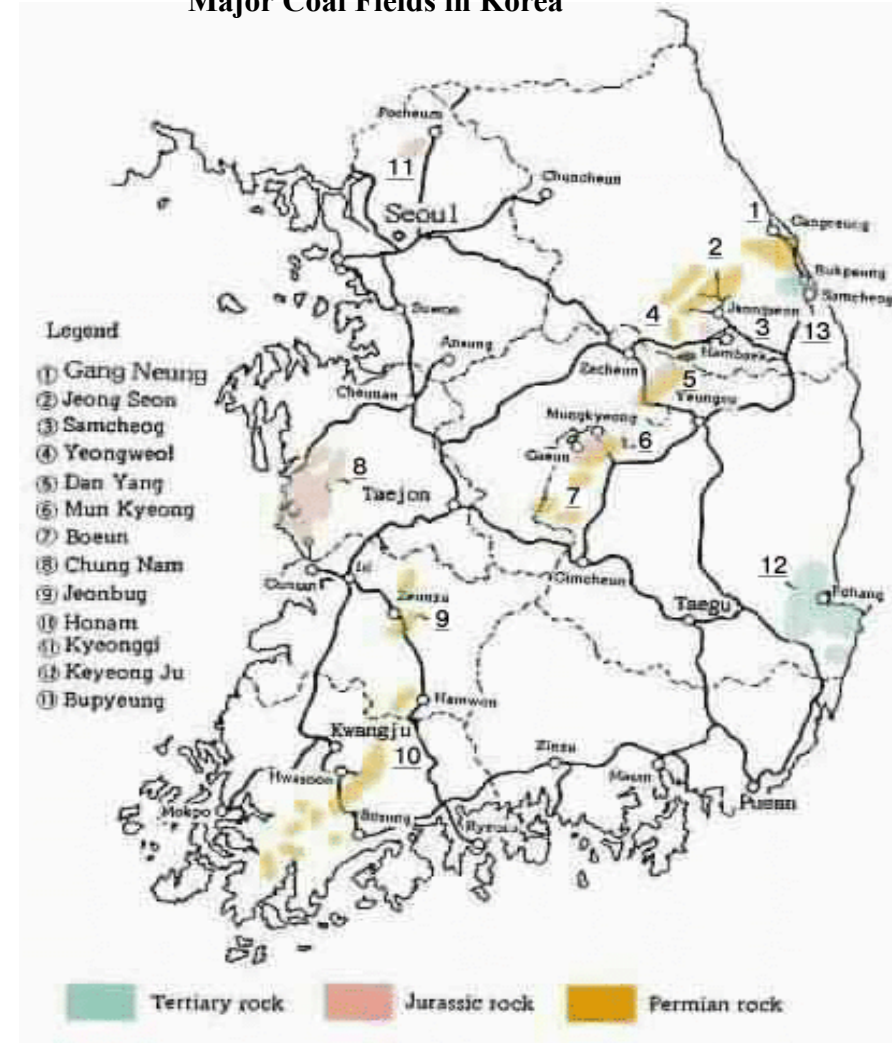


Source: Korea National Oil Corporation, Homepage: [www.knoc.co.kr](http://www.knoc.co.kr)

# Coal Development in Korea

- **Production Promotion in past**
  - Heavy subsidization for production increase in the 1970's
- **Active Rationalization from the 1990's**
  - Low productivity
  - Significant demand decreases
  - **No. of mines: 332 (1989) → 27 (1995) → 11 (2004) → 5 (2010)**
- **Coal production decreased:**
  - **19.8 million ton (1990) → 2.1 (2010)**

Major Coal Fields in Korea



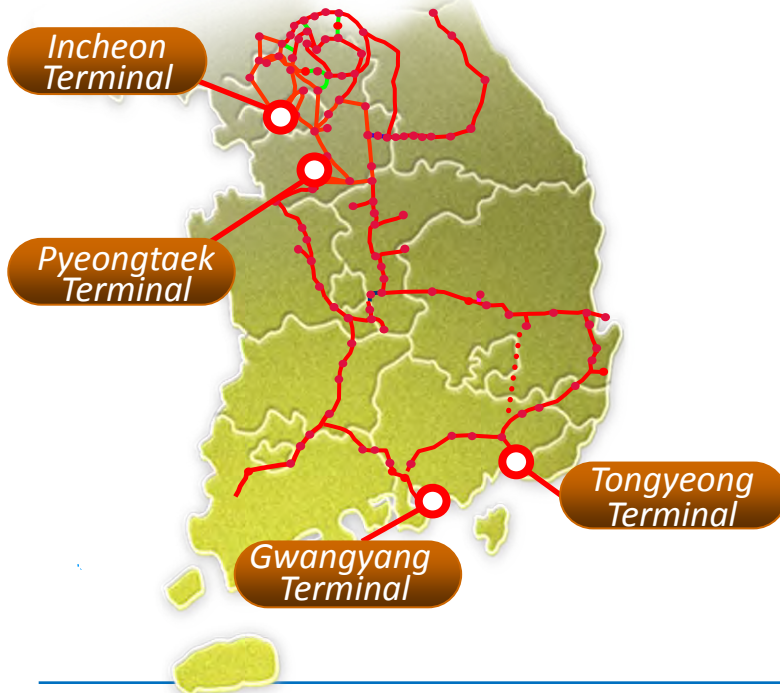
# Natural Gas Industry in Korea

## LNG Terminals and Pipeline

- 4 LNG terminals and a nationwide pipeline networks for transport of natural gas

### National Pipeline Network

- Storage : 6,320 th.kℓ (48 tanks)
- Main Pipeline : 2,777 km
- Regional Pipeline : 31,435 km



[Bird's-eye view of LNG terminal]

(As of Dec. 2009)

LNG Terminal	Start	Storage Capacity (1,000 kℓ, #)	Re-gas Capacity (Ton/h)
Incheon	Oct. 1996	2,880 (20)	3,690
Pyeongtaek	Nov. 1986	1,560 (14)	3,376
Tongyeong	Sep. 2002	1,680 (12)	1,530
Gwangyang	Jul. 2005	200 (2)	170
<b>total</b>		<b>6,320 (48)</b>	<b>8,766</b>

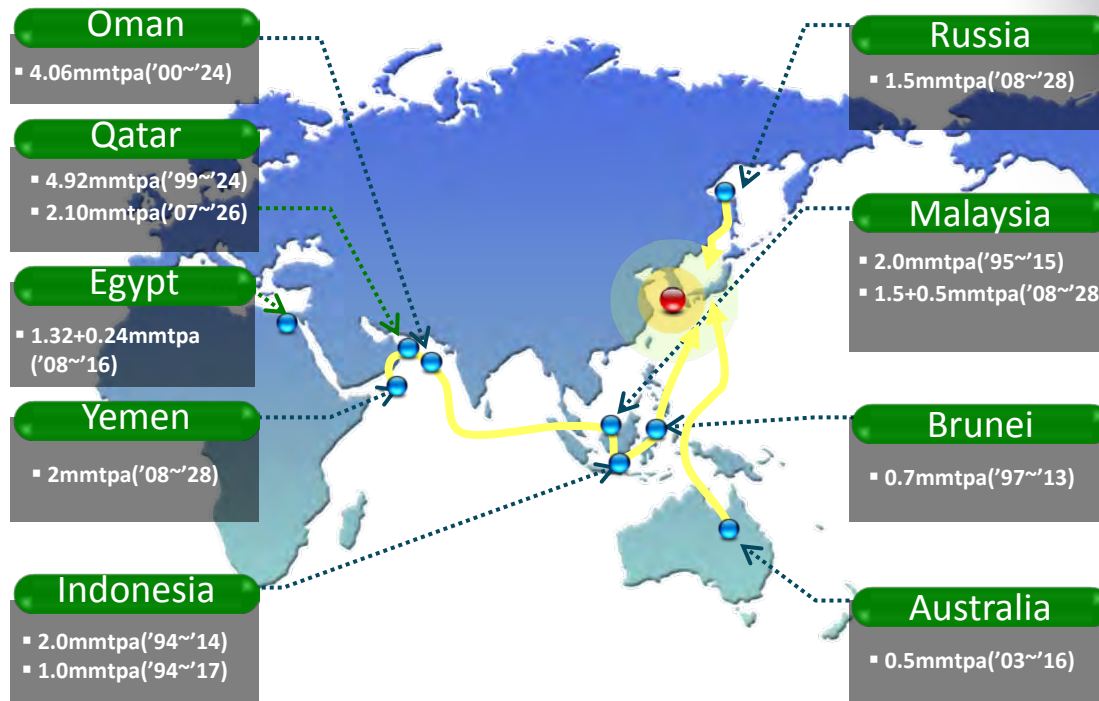
# Natural Gas Industry in Korea

## Natural Gas Import

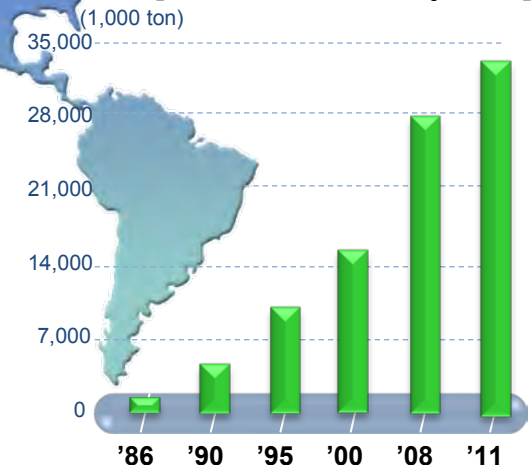
- The world's 7<sup>th</sup> largest natural gas importing country
- Natural gas imported from 9 countries by ship (LNG)
  - ✂ Korea is the world's largest LNG shipbuilder



[LNG ship built in Korea]



[Natural Gas Imports]





# Electricity Development in Korea

## ■ Government Initiatives

- **KEPCO**

- 6 Power Gen Companies

- Transmission/Distribution by KEPCO

## ■ Fuel Diversification

- **Power generation capacity by fuel**

(1980 → 1990 → 2011, %)

- Oil ↓ : 62.3 → 18.4 → 10.1

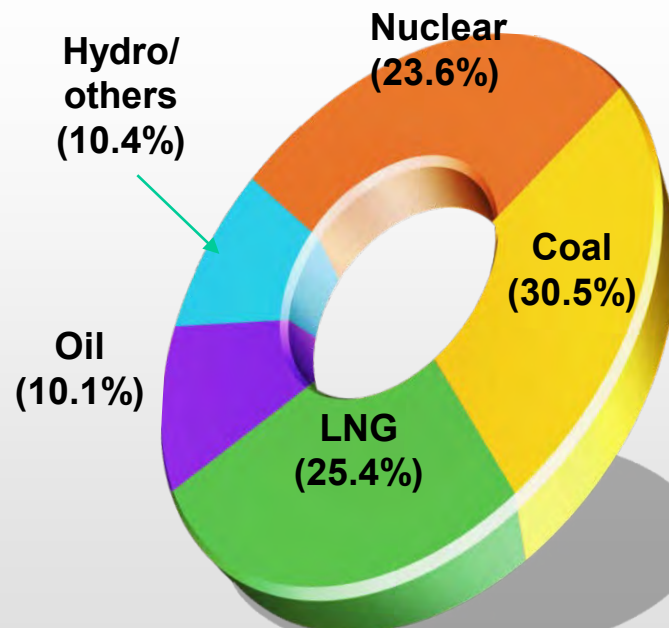
- Coal ↑ : 8.0 → 17.6 → 30.5

- LNG ↑ : 0 → 16.1 → 25.4

- Nuclear ↑↓ : 6.3 → 36.2 → 23.6

## ■ Challenge: Sites for power plants

Power Generation Capacity ('11)

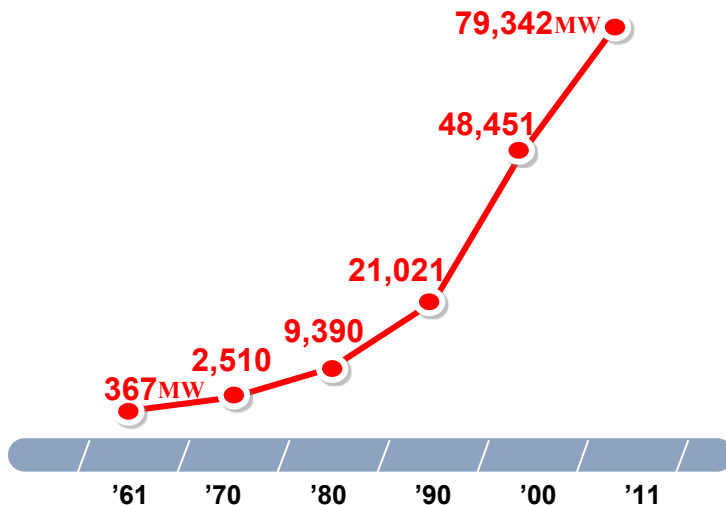


Total : 79,342 MW

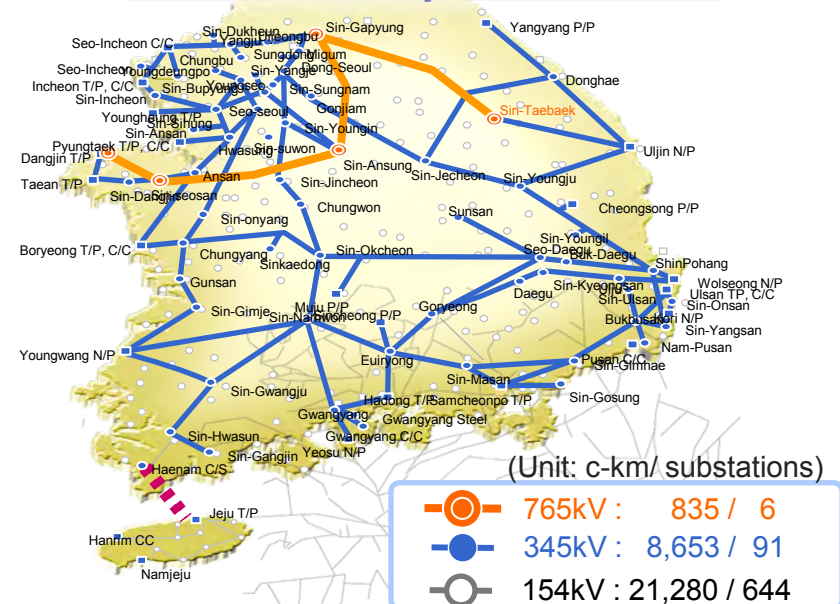
# Electricity Development in Korea

- **Rapid expansion of power generation capacity**
  - Power generation capacity : (1961) 367 MW → (2011) 79,342 MW (more than 200 times increase)
- **Establishing a nation-wide transmission and distribution(T&D) network**
  - Circuit length : (1961) 2,384c-km → (2011) 31,249c-km, No. of substations : (1961) 291 → (2011) 749
  - Power line length : (1961) 9,171c-km → (2011) 435,549c-km
- **The quality of T&D reached the world-class level**

**Power Generation Capacity**



**Transmission System Network**



# Power generation by fuel

❑ Nuclear power : 30.3% of electric power production (2011)

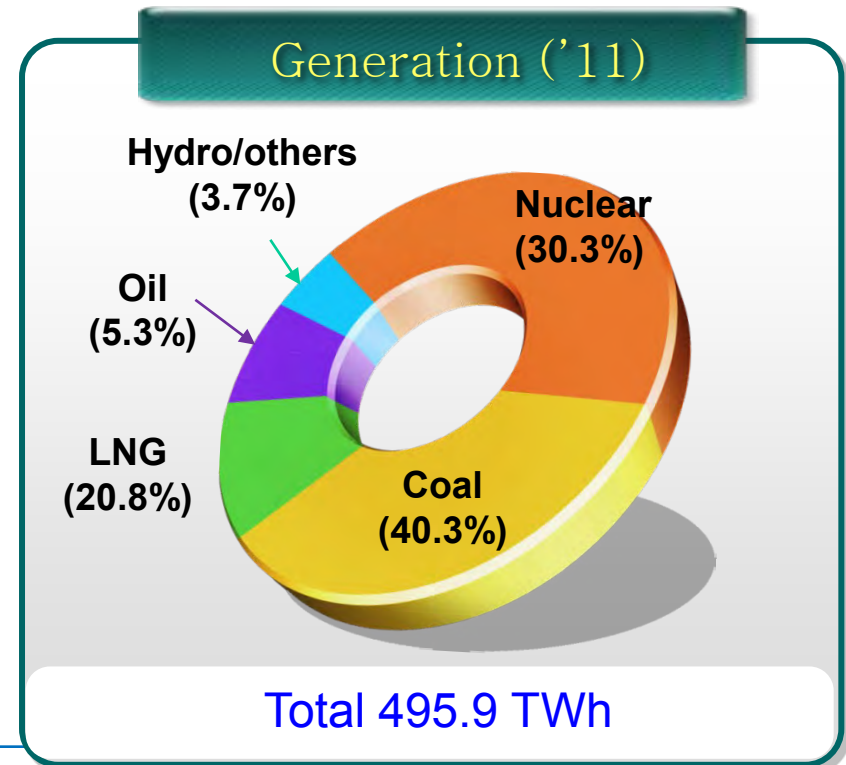
✓ 2<sup>nd</sup> largest generation source following coal-fired(40.3%)

❑ Big increase of LNG-fired : 20.8%(2011) from 15.1%(2009)

❑ Power generation by fuel

(1981 → 1995 → 2011, %)

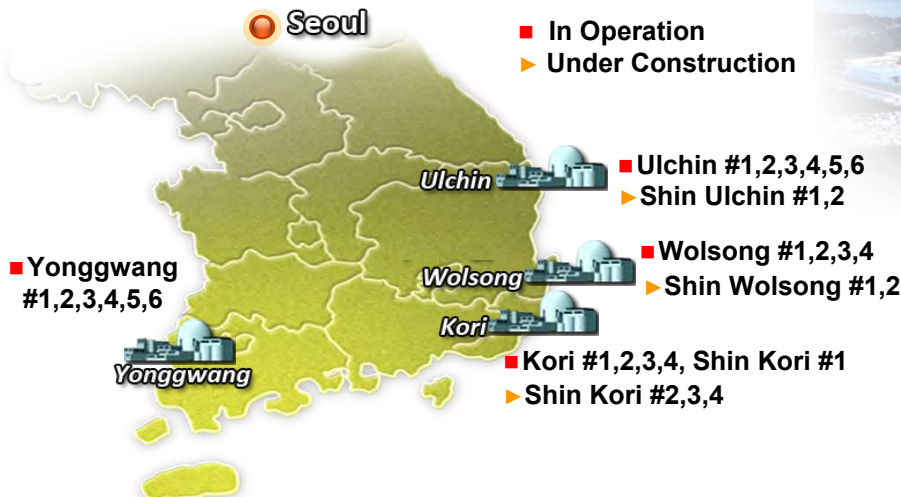
- Oil ↓ : 79.8 → 22.8 → 5.3
- Coal ↑ : 6.3 → 26.4 → 40.3
- LNG ↑ : 0 → 11.5 → 20.8
- Nuclear ↑ ↓ : 7.2 → 36.3 → 30.3



# Nuclear Power Industry in Korea

- Korea operates a total of 21 nuclear power plants as of Dec. 31, 2011
- Korea possesses 95% technological independence with its Korean type nuclear reactors of OPR1000 and APR1400
- Korea won an order of building a nuclear power plant in UAE (2009. 12)
  - UAE Nuclear Energy Corporation (ENEC) selected the consortium of KEPCO as the final business proprietor for UAE nuclear power plant business (about 20 billion dollars deal)
  - Also, Korea conducted a research and training project in Jordan

## Nuclear Power Plants



Site	In Operation	Under Const.	Total
Kori	5 (4,137)	3 (3,800)	8 (7,937)
Wolsong	4 (2,779)	2 (2,000)	6 (4,779)
Yonggwang	6 (5,900)	-	6 (5,900)
Ulchin	6 (5,900)	2 (2,800)	8 (8,700)
<b>Total</b>	<b>21 (18,716)</b>	<b>8 (8,600)</b>	<b>28 (27,316)</b>

(As of Dec. 31, 2011, Units: MW)

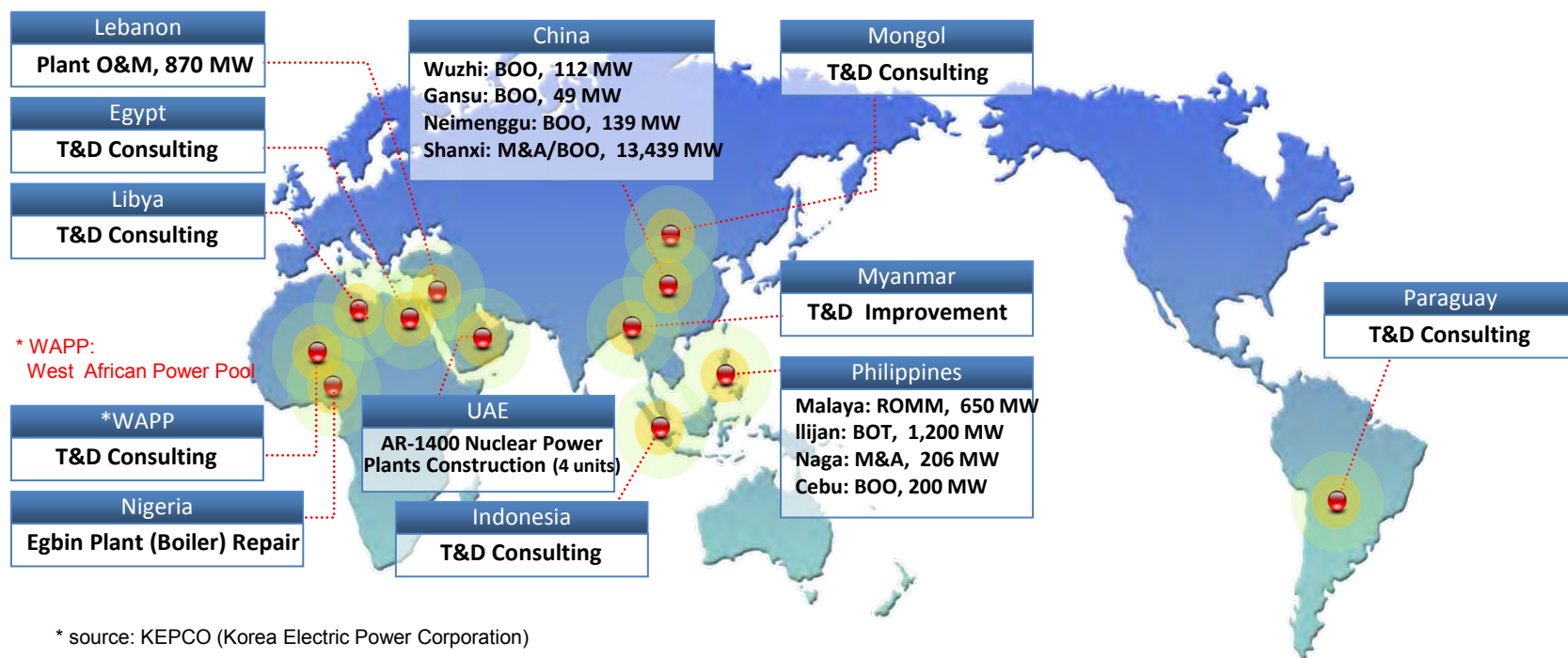


# Electricity Development in Korea

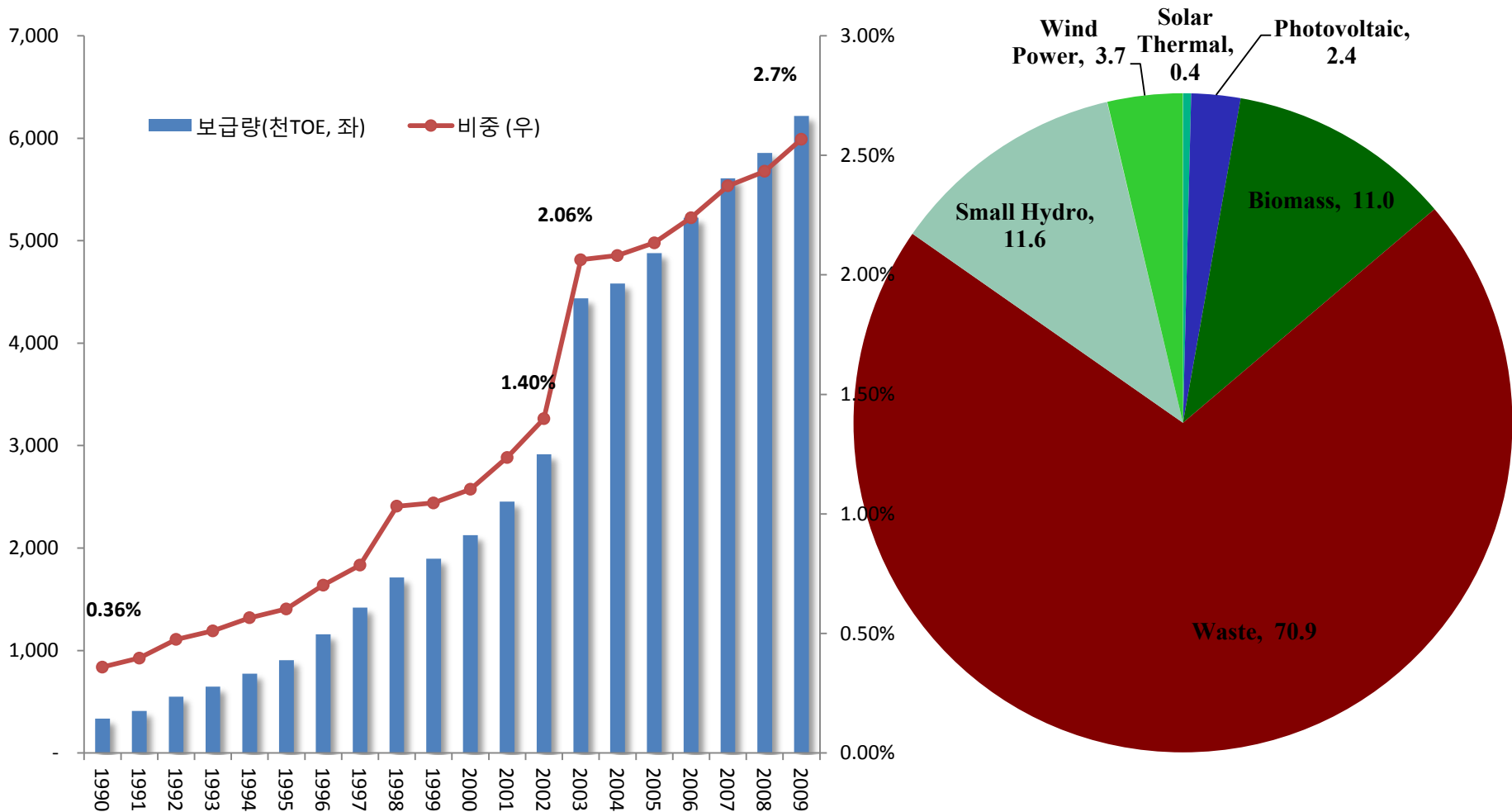
## Nurturing Power Industry as New Growth Engine

- Power generation plants, transmission and distribution system, nuclear power plant, EPC and operation, management etc.

### KEPCO's Overseas Projects in Operation



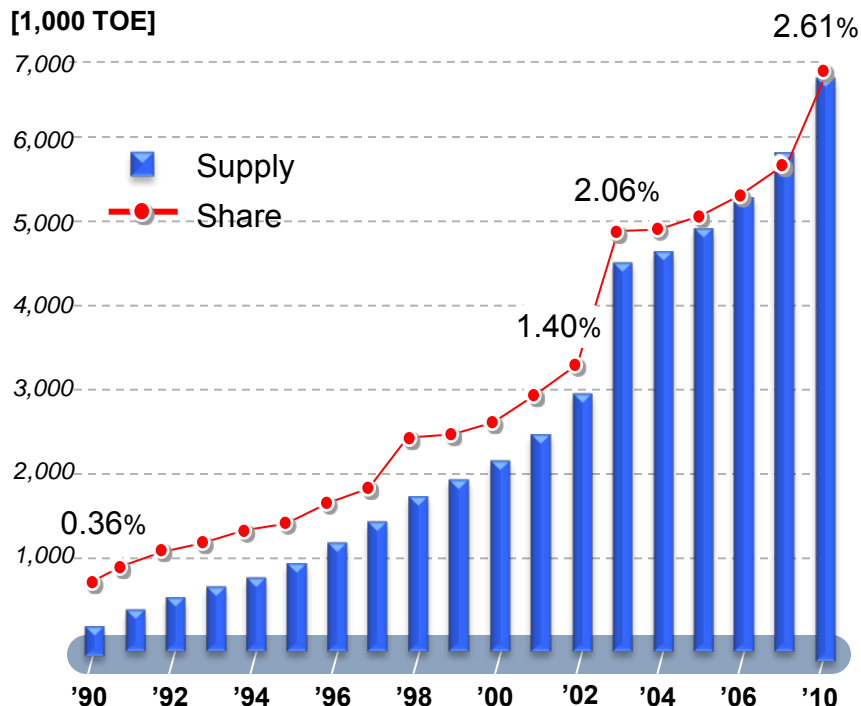
# Renewable Energy in Korea



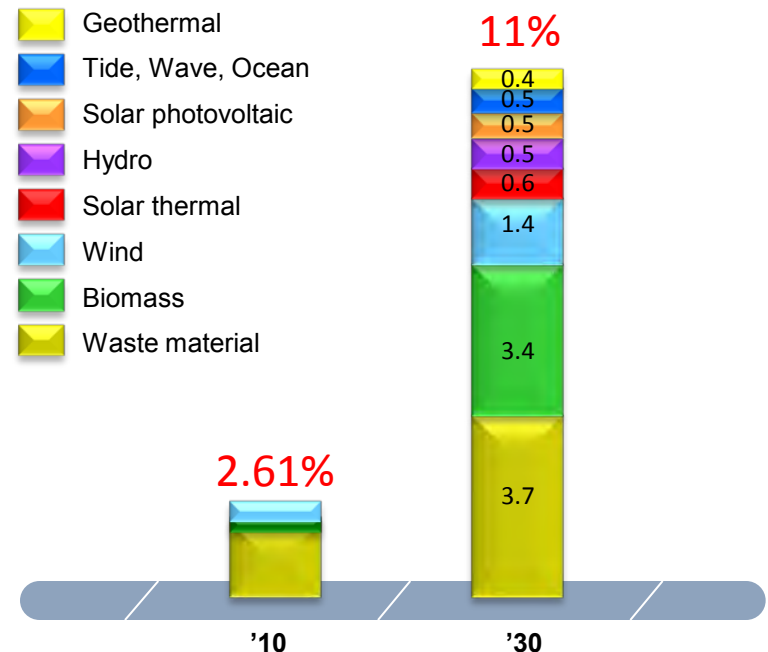
# Renewable Energy in Korea

- Renewable energy supply has increased at an annual rate of 16.3% during 1990-2010 (2.61% share in total energy consumption in 2010)
- Target for renewables share in energy mix : 11% (2030)
  - Key sources for renewable energy: bio-fuel, wind power, solar energy

## Supply Trend of Renewable Energy



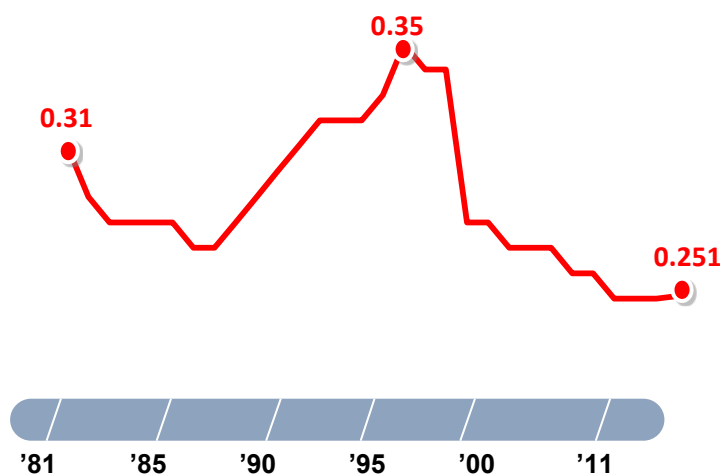
## Target for Renewables (2030)



# Energy Saving and Energy Efficiency Improvement

- Korea's energy intensity has declined steadily since its peak in 1997
  - Energy efficiency has improved 1.1% per year from 1998 to 2011
  - Energy efficiency in Korea is one of the lowest in OECD countries (29th) due to the high share of manufacturing industry and energy intensive industries
- Especially, Korean power industry's efficiency has greatly improved
  - The T&D loss rate, one of the indicators of power industry's efficiency, has steadily improved to 3% level in 2011, even lower than the major developed countries (Japan 5%, USA 6%)

Energy Intensity (toe/million won)



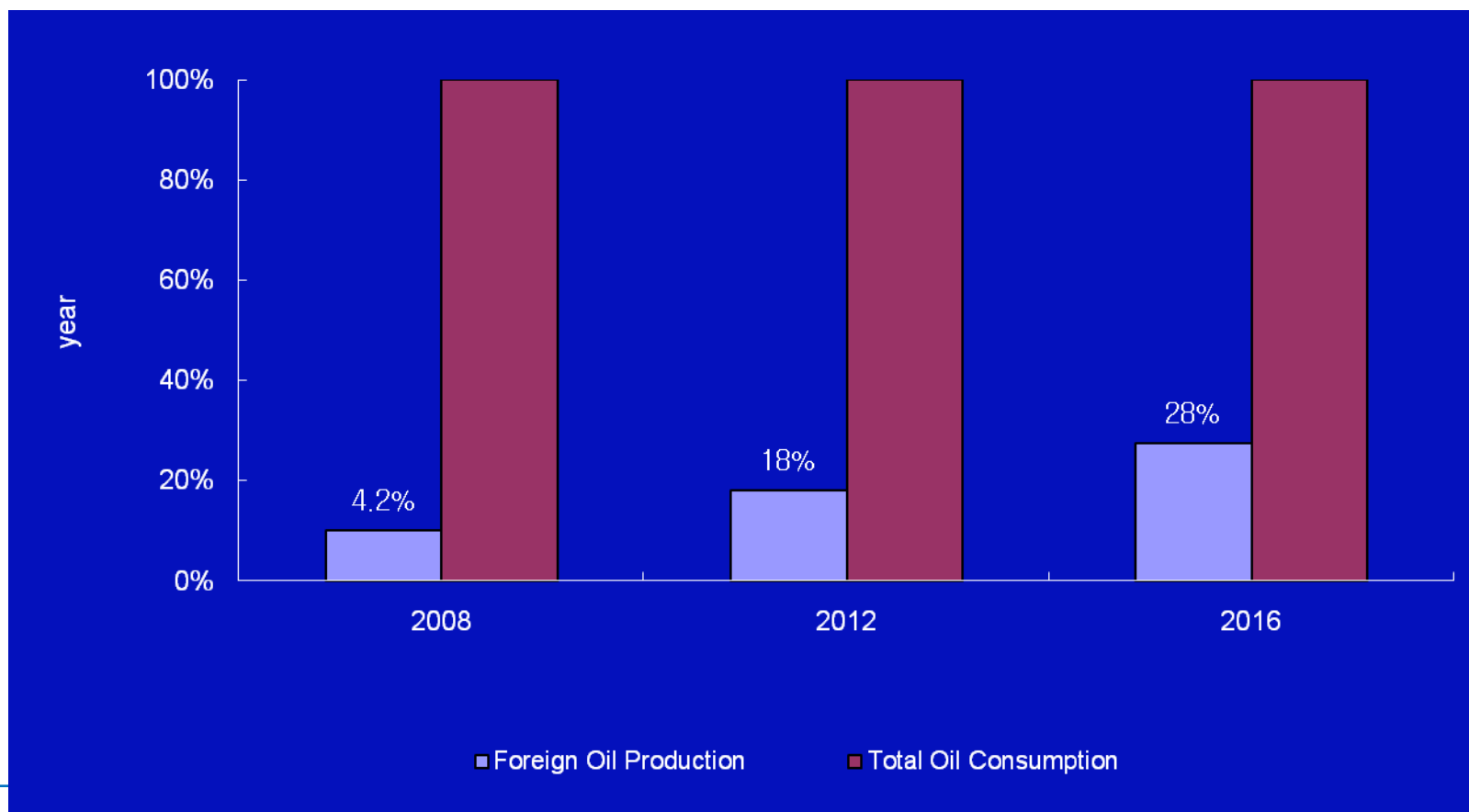
T & D Loss Rate (%)



# Overseas Energy Resource Development

## ■ Government's target of overseas E & P business

- Overseas Oil Producing Amount equivalent to 18% of oil imports by 2012 and 28% by 2016 in overseas oil fields

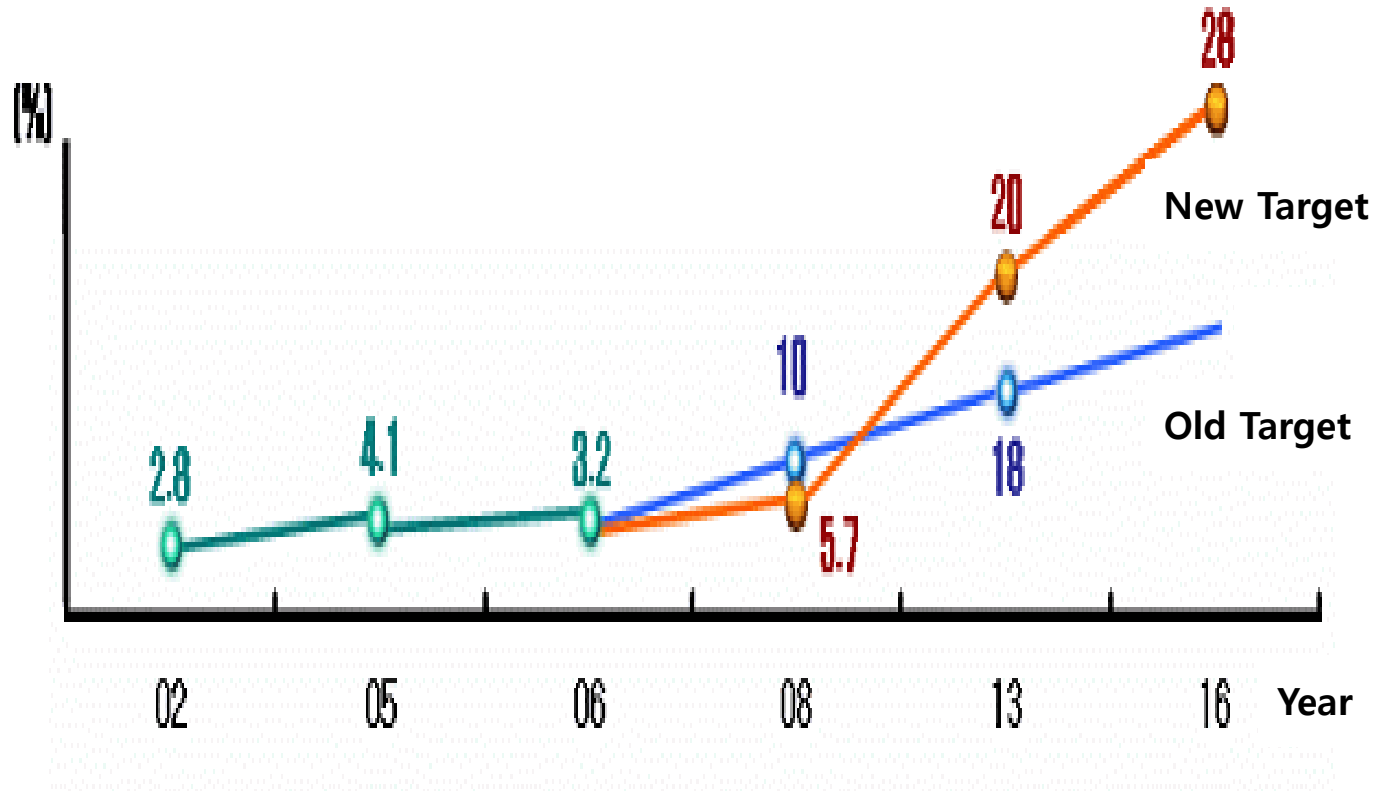


# Policy and Target for Overseas Resource Development

## ● Korea pursues more active overseas resource developments

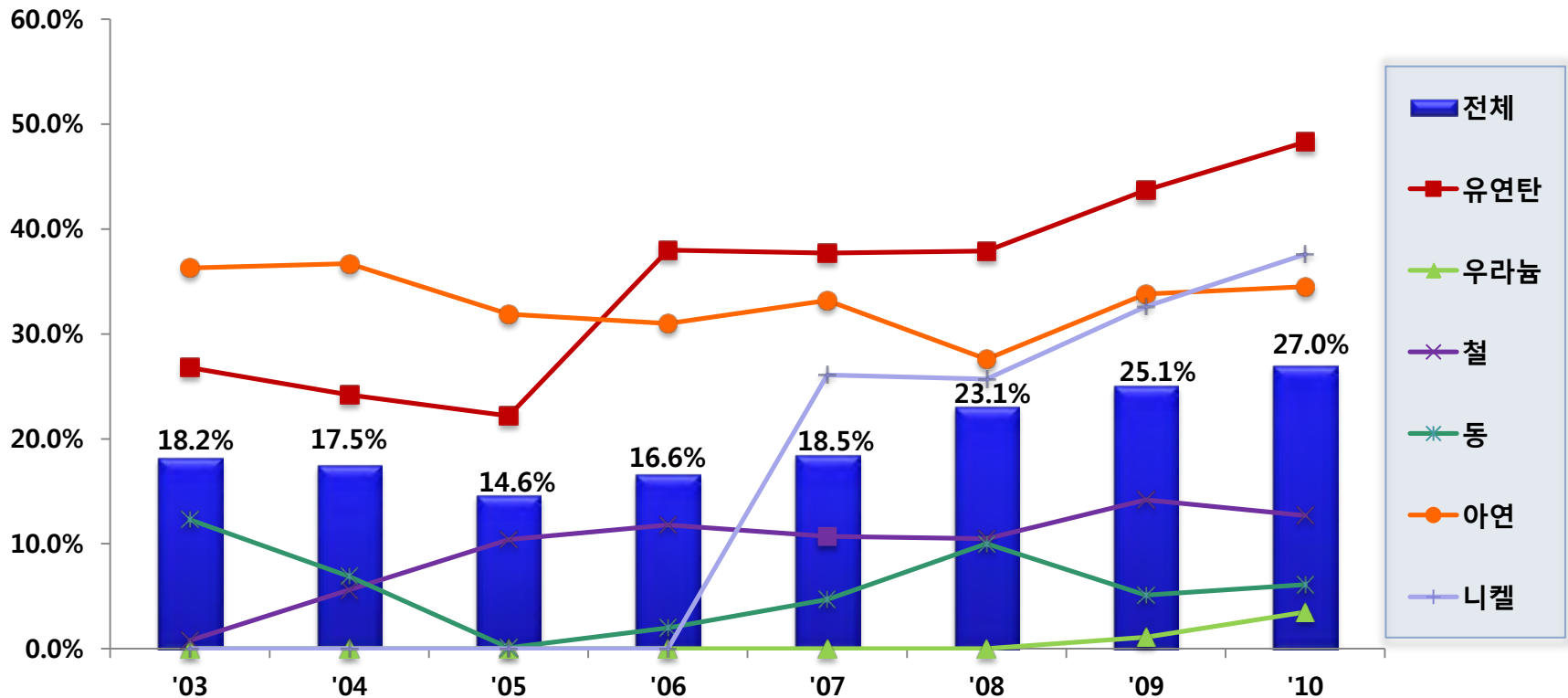
### - Target ratio of overseas resources development: 28% (2030)

- Promotion of overseas exploration and production businesses to the companies
- Strong government supports for fostering technologies and human resources over energy development



# Korea's Overseas Resource Development

- Total project number: 505 in 64 countries (oil & gas 198, Mineral 307)
- Achievement (2011): Oil & Gas 13.7 %, **Coal 52.2 %**, **Uranium: 6.6 %**, **Iron Ore: 15.3 %**, **Copper: 10.2 %**, **Zinc: 24.7 %**, Nickel: 30.5 %



# Energy Technology Development

- Achieved a technological independence and localization in a short period of time by absorbing and introducing foreign technology
  - Benchmarking some institutions of advanced countries, technical exchanges and cooperation
  - Increasing R&D investments in energy technology
  - Vitalizing joint R&D efforts among universities, research institutions and private companies
- Reached a world-class energy plant technology
  - Drill ship, FPSO (floating production storage and offloading)/FSO (floating storage and offloading), LNG carrier, nuclear power, T&D, petroleum refinery and so on

## Drill Ship

- Offshore drill ship
- Arctic shuttle tanker



## FPSO

- Crude oil-FPSO/FSO
- LNG-FPSO



## LNG Carrier

- Membrane-type
- LNG-RV (Regasification vessel)



## Nuclear Power

- APR1400 (New nuclear Reactor)





# Energy Demand Outlook in Korea (2030)

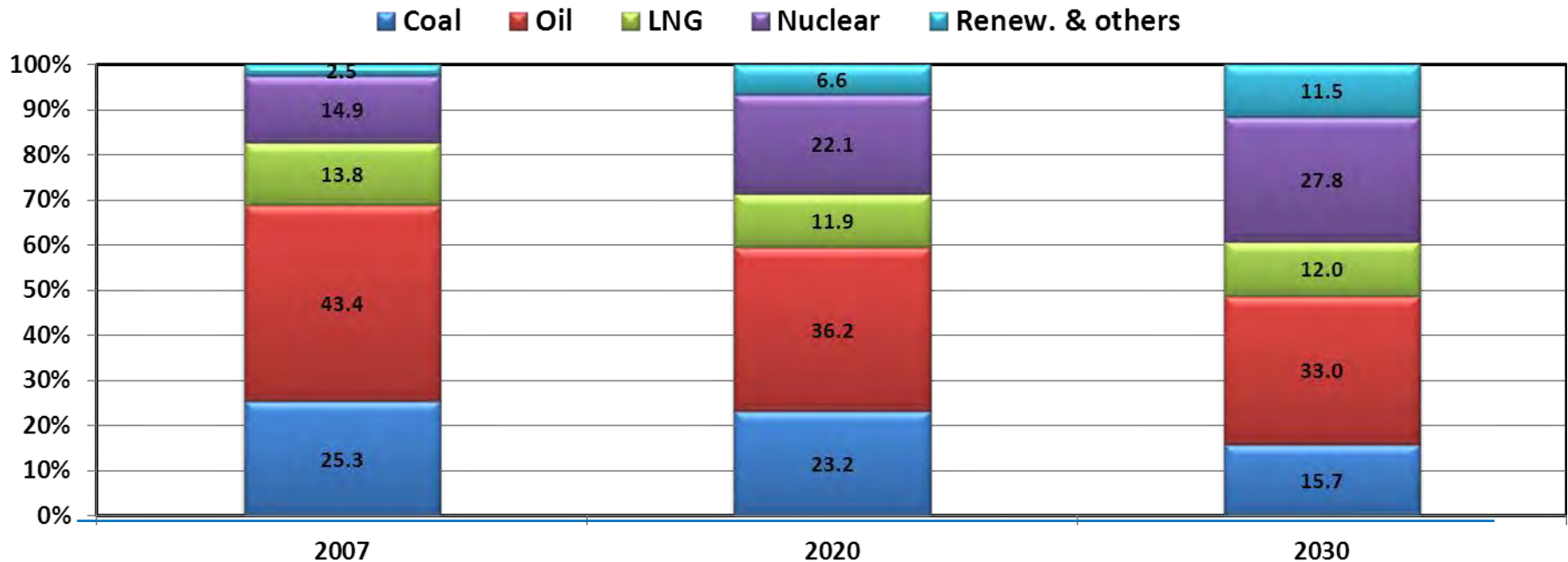
	Energy Demand (million toe)				
	2006	2010	2015	2020	2030
<b>Total Primary Energy</b>	<b>233.4</b>	<b>258.7</b>	<b>268.6</b>	<b>311.6</b>	<b>334.3</b>
<b>Coal</b>	<b>56.7</b>	<b>68.9</b>	<b>73.9</b>	<b>79.5</b>	<b>83.8</b>
<b>Oil</b>	<b>101.8</b>	<b>106.6</b>	<b>109.8</b>	<b>115.1</b>	<b>119.7</b>
<b>LNG</b>	<b>32.0</b>	<b>38.3</b>	<b>41.4</b>	<b>46.1</b>	<b>51.5</b>
<b>Nuclear</b>	<b>37.2</b>	<b>37.1</b>	<b>50.8</b>	<b>57.2</b>	<b>62.5</b>
<b>Hydro</b>	<b>1.3</b>	<b>1.3</b>	<b>1.3</b>	<b>1.3</b>	<b>1.5</b>
<b>Renewables</b>	<b>4.4</b>	<b>6.5</b>	<b>9.4</b>	<b>12.3</b>	<b>15.4</b>

Source: National Energy Strategy 2030, 2009, Ministry of Knowledge Economy, Korea



# Energy Mix Target

- **Long-term Energy Mix in the 1<sup>st</sup> National Energy Plan (2008)**
  - **Reduction of use of fossil fuels to decrease GHG emissions**  
: Coal ↓, Oil ↓, LNG ↓
  - **Expansion of renewable energy and nuclear power capacity**  
: renewable energy : from 2.5% in 2007 to 11.5% in 2030  
: nuclear energy : from 14.9% in 2007 to 27.8% in 2030
- **Reality seems to have been away from the plan due to the impact of Fukushima accident (2011)**



# Future Challenges

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## ■ **Securing Long Term Stable Energy Resources**

- **Strengthening Energy Diplomacy with energy producing/exporting countries**
  - ME, SE Asia, Australia
  - Russia, Central Asia/Caspian region
- **Regional Energy Cooperation in Northeast Asia**

## ■ **Environmental Pressures**

- **Local: Air pollution, Sites for energy facilities (nuclear power plants)**
- **Global: Mitigate Greenhouse gases**

⇒ **Low-carbon energy system**

## ■ **Energy Security in the Korean Peninsular**

- **Energy Crisis/Poverty Problem in North Korea**
- **Energy Market Integration between South-North Korea**

# International Energy Cooperation Strategy

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## ■ Comprehensive Approaches

- **Combining Energy + High-value Added Industry + Infrastructure Development Projects**
- **Enhancing partnership between government and business sectors**
  - **to Improve trade/investment environment**

⇒ **Korea–Saudi Arabia energy cooperation can provide with a win-win opportunity**

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**Thank you very much**

*Gamsa'hamnida*

**- End -**