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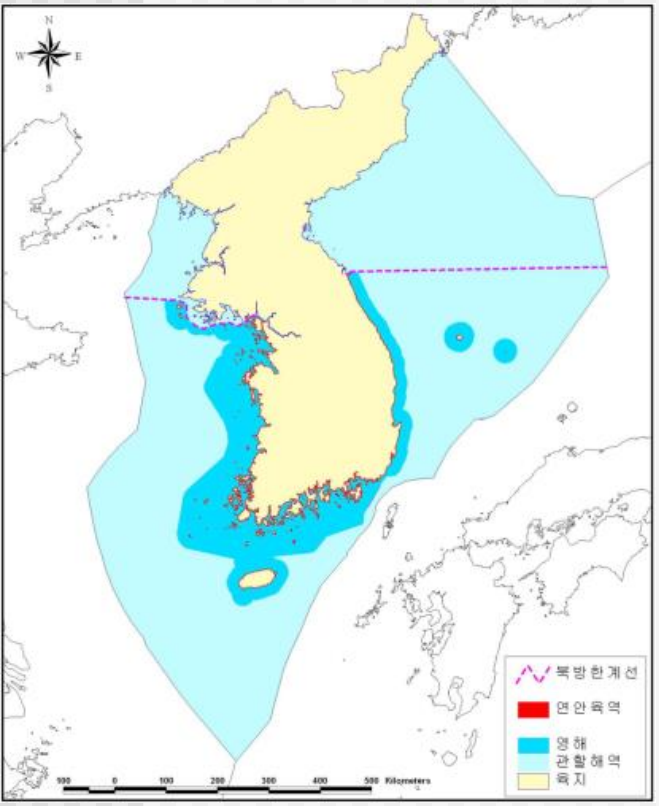
1. Introduction



- East Sea: 1,700km x 1,100km, average depth: 1,361km, temperature is low
- Southern coast: deeply indented by estuaries and bays, a large number of islands, average depth: 101m,: 6~29C
- Yellow Sea: 1,000km x 700km, temperature: 25~27C summer and 2~8C winter, tidal gab; 5~10 meters, tidal current; very strong

1. Introduction

- Total offshore energy resources: 18,000 MW
  - Tidal power energy: 6,500 MW (west coast)
  - Wave power energy: 65,000 MW (Jeju Island & East Sea)
  - Tidal current energy: 1,000 MW (south west coast)
  - Ocean thermal energy conversion: 4,000 MW
- Goal for developing the offshore energy in national plans is low compared with other renewable energy.

2. Status of Offshore Energy Development

2.1 National Offshore Energy Development Program

- MOF: tidal power energy, tidal current energy, wave power energy, ocean thermal energy
- MOTIE: offshore wind energy

- KRW156.2 bi invested for offshore energy development (2000-2014)
  - KRW49.0 bi for tidal current
  - KRW48.2 bi for wave power
  - KRW8.9 bi for tidal power
  - KRW20.5 for OTEC
  - KRW29.6 for complex generation.

2.2 Tidal Power Energy

- Siwha Tidal Power Plant
  - Commercialized since 2011

- Tidal power plants at the Garolim Bay and the Incheon Bay
  - Suspended and state of standstill

Siwha Tidal Power Plant: History

- Siwha Lake Reclamation Project
  - Construction of 12.7 km dyke
  - To keep 180 mi tons of fresh water
  - To create land of 110 square kilometers by reclamation of wetlands and estuaries for rice production, industrial complexes, and a new city
- Construction of dyke for 1987-1994

History

- Two large industrial complexes and a new city (Ahansan City) built before completing the dyke
- 127,000 tons of industrial wastes and 49,000 tons of sewage flowed into the lake
- Many farms built in the watershed and 9,000 tons of BOD flowed into the lake

Siwha Tidal Power Plant: History

- Land-based sources of pollution heavily degraded the lake and water could not be used for agriculture.
- In 1991, officially declared the abandonment of keeping freshwater in the lake
- Opened regularly gates of the dyke to flush out the polluted water from the lake and to take seawater.

Siwha Tidal Power Plant: History

- Quantity of seawater was only 16 million tons a day, only 8.9% of the storage capacity of the lake.
- Two gates were built 10 meters higher than the bottom of the seabed, and the waters below the gates could not circulate well.
- In 2002, a project for building a tidal power generator in the dike established to produce electricity and also to clean the polluted water of the Siwha Lake
- KRW355.1 bi invested from 2003 to 2011

Siwha Tidal Power Plant: Capacity

- Generating electricity two times a day, using the water fall at high tide
- 254 MW with 10 water-turbine-generators of 25400 KW
- 552GW of annual power production

* Rance Tidal Power Plant: 544GW of annual power production

Siwha Tidal Power Plant: Capacity

- Water-turbine-generator: three wings of diameter 7.5 meters, 64.29 rpm
- 482.13 cubic meters of water per second
- max, regular, min waterfall: 7.50m, 5.82m, 1.00m

Siwha Tidal Power Plant: Capacity

- 8 sluice gates with 15.3m width, 12m height
- Total circulation of the seawaters: 147 million cubic meters a day

  * A half of the total waters of the Lake Siwha is circulated
- Total production
  - 0.5 bi KW until December 2012
  - 1.0 bi KW until December 2013
  - 1.5 bi KW until January 2015

Siwha Tidal Power Plant: Effects

- Improve water quality COD 2.0 ppm

  * Similar to the level of the coastal waters outside of the Lake.
- Annual power production of 552GW
- Supply a city of 500,000 inhabitants
- Reduction of CO2 emission of 315,000 tons annually
- Oil import substitution effects of 862,000 barrels yearly
- Marine-based tourism and leisure activities with 1.5 million people yearly

Garolim Tidal Power Plant

- Planned to construct a dike of 2,053m
- Planned to create land of 96.03 square kilometers
- Planned to invest KRW1,022.5 billion
- in October 2014, tMinistry of Environment rejected EIA
- Strong opposition from NGOs and fishermen
- The plan at a standstill and virtually cancelled

2.3 Tidal Current Power Energy

- Uldolmok Tidal Current Power Test Plant

– The Uldolmok Strait: max current of 11 knots and width of 294m

– Succeeded in proof for development of scientific technologies

– Not entered the stage of the semi-commercialization

– Pilot project by investment of KRW13.0 bi from 2005 to 2009

Tidal Current Power Energy

- Uldolmok Tidal Current Power Test Plant

  - Total power capacity: 1 MW with 2set of 500kW
  - Structure: 16m x 36m x 48m, 1000 tons of weight
  - Planned to produce 90,000 KW from 2013
  - Poor economic feasibility and 2012 typhoon caused to stop operating

Tidal Current Power Energy

- Jangjook Tidal Current Power Plant

  - Planned to develop a large MWh system of the tidal current power plant in the Strait of Jangjook from 2010 to 2014
  - Five private businesses participated in the project
  - Planned to invest a total of KRW16.5 billion: KRW7.2 bi by the government and KRW9.3 bi by the private businesses
  - Suspended from 31 May, 2014 due to difficulties of construction

2.4 Wave Power Energy

- The Jeju Wave Power Plant

– Constructed for a pilot project by investment of KRW25.5 bi for 2003 to 2015

– Site: at 1km from the west coast of the Jeju Island

– The average depth is 16 meters.

– Concrete caisson: 37m x 35.2m x 29.5m with 12,000 tons of weigh

– Total power capacity: 500KW with 2set of 250KW

2.5 Offshore Wind Energy

- Land space for wind energy plans is limited
- Opposition of the residents has become strong
- Demand for the offshore wind energy is increasing
- RPS started to assign the large-scale producers to mandatorily renewable energy
- To supply 2% until 2012 and 10% until 2020
- Many sites are under planning to develop by various organizations in the south western coast

2.6 Offshore Thermal Energy Conversion (OTEC)

- OTEC is in the early stage and R&D is underway.
- In 2014: a plant of 200kw was made.
- In 2015, a design for a plant of 1MW and its mounting structure is developed.

3. Institutional Tools for Offshore Energy Development

3.1 CZM Program

- Enactment of CZM Act in 1999
- Tried but failed to introduce a zoning system due to strong opposition from MOCT and ME
- Introduced a networking system with weak mandate
- No financial or institutional incentives to local governments

CZM Program

- CZM Program: National CZM Plan, Local CZM Plans, Coastal Zone Enhancement Plans
- Boundary: coastal water zone of territorial waters and 500 meters inland
- National CZM Plan established by the central government in 2000

- Inclusion of contains six major components in the 10 coastal regions, indicating direction for future management that Local CZM Plans to be established

Zone	The basic policy directions
Mid-part of West Sea - I	Management of pollution load
Mid-part of West Sea - II	Preservation of coastal scenic area, Enhancement of stewardship
Southern part of West Sea - I	Multipurpose use of coastal resources
Southern part of West Sea - II	Development of islands, Preservation of wetlands
Western part of South Sea	Conservation of fisheries resources, Enhancement of coastal tourism
Mid-part of South Sea	Conservation of fisheries resources, Management of pollution load
Eastern part of South Sea	Ocean-friendly city planning
Southern part of East Sea	Management of pollution load, Protection of islands ecosystem
Mid-part of East Sea	Preservation of coastal scenic areas, Enhancement of coastal tourism
Jeju Island	Protection of island ecosystem, Enhancement of coastal tourism

CZM Program

- Local CZM Plans established voluntarily by local governments
- Local CZM Plans: (i) statements of policies, (ii) the procedure whereby the policies and guidelines of the national plan to be implemented, and (iii) policies and priorities of the application of coastal zone readjustment projects.

CZM Program

- In 2000, the Guideline for Establishment of Local CZM Plans established by MOMAF
- Similar to National CZM Plan, Local CZM Plans have weak mandate but rather agreement for the future development and use.
- In 2009, MOMAF revised the CZM Act to introduce the zoning system in the coastal water zone: the usable area, the special area, the conservation area, and the management area

3.2 Permit for Occupancy and Use of Public Water

- Public Waters Management and Reclamation Act (PWMRA) states that anyone who wishes to occupy or use the coastal waters privately should get permit from Management Agency of Public Waters (MAPW)

- MAPW Presidential Decree states that building followings can get permit:

  – wind power facilities among the Renewable Energy Facilities regulated in the Act on the Promotion of the Development and Use of Alternative Energy;

  – Transmission line and associated facilities regulated in the Electric Utility Act.

Permit for Occupancy and Use of Public Water

- Permits for the wind power facilities and the transmission line and associated facilities should be applied separately.
- MAPW and presidential decree do not include other facilities of offshore energy except offshore energy explicitly.

3.3 Ocean-Space Use Consultation

- EIA on the project at sea should be conducted for construction project of
  - over 10MW of electricity
  - over 100MW of offshore wind energy development.
- EIA need not be conducted for smaller projects than the above.
- In 1999, MOF introduced the “Ocean-Space Use Consultation” for all projects at sea in the Marine Environment Management Act (MEMA).

3.3 Ocean-Space Use Consultation

- Local governments to consult with the local MOF office with relevant documents before giving permits, licenses, and designations to “ocean-space users” based on the Public Water Management and Reclamation Act, the Fisheries Act, and the Aggregate Mining Act.

- Local MOF office approves or rejects the requested “Ocean-Space Use Project” after reviewing the relevant documents.
- “Ocean-Space Users” should conduct environmental impact assessment stated in the Presidential Decree of MEMA, which should be presented to local governments when applying for permission.

4. Prospect of Offshore Energy Development

4.1 National Goal for Offshore Energy Development

- The Sixth National Electricity Supply & Demand Basic Plan, established in August 2013
  - To produce the offshore energy of 2,480GWh in 2025, 3.2% of renewable energy of 77,364GWh

4.1 National Goal for Offshore Energy Development

- The Second National Energy Basic Plan, established in January 2014
  - To produce offshore energy 2.4%, 1.6% and 1.3% among the renewable energy in 2020, 2025 and 2035
- Fourth National Renewable Basic Plan, established in 2014
  - To produce the offshore energy 1.6% of the total renewable energy in 2025
  - To introduce a variable REC weight value to attract investment of the private business

4.2 Mid- and Long-term Offshore Energy Development Plan (2015-2025)

- Established by MOF and MOTIE in July 2015

  - To produce the offshore energy 1.6% of the total renewable energy until 2025

  - To increase technologies of the offshore energy from 79% in 2012 to 95% of the technology-advanced countries until 2025;

  - To foster five small & competitive offshore energy businesses until 2025.

Wave Energy

- To develop a tidal power system optimized in the coastal waters of Korea through test operation (2015-2016) of the Jeju Pilot Wave Energy Plant
- To accelerate a floating-type wave energy generating system (2015-2016, 300KW), which is using the deep sea wave energy

Wave Energy

- To develop a small-size wave energy generating system to supply electricity to small islands
- To expedite commercialization through establishment of a real-ocean test bed, which is connected with the Jeju Pilot Wave Energy Plant (2016-2021), and through construction of a private-oriented test bed

Tidal Current Power

- To develop and operate an active control-type generating system for early commercialization by participation of the private sector until 2018, and to expedite commercialization through transfer of the technologies

- To establish a real-ocean test bed through expansion of the Uldolmok Tidal Current Power Plant (2017-2022) and to expedite the commercialization

  - To establish five sites of real-ocean test beds (4 sites of 1MW and 1 site of 0.5MW)

Jeju Tam-La Ocean Wind Energy Plant

- Oct 2015: Completed development & Started operation
- A total of 10 wind energy power units
- Annual Production: 30MW

S/W Ocean Wind Energy Development Project

- Site: South West Coast of Korea
- 2010: Korea Government announced Road Map to produce 2.5 GW
- 2011: Agreement between Government and KEPCO + 6 Electricity Generation Companies + Big Private Businesses
- Delayed due to Resident opposition and permit from relevant government departments
- 2004~2005: Permits from MOF

S/W Ocean Wind Energy Development Project

- Test Bed
  - Until 2018, Production: 80MW
  - KEPCO + 6 Electricity Generation Companies
- Pilot Project / TrackRecord
  - 2018~2020, Production: 400MW
  - KEPCO + 6 Electricity Generation Companies
- Main Project
  - After 2020, Production: 2,000MW
  - KEPCO + 6 Electricity Generation Companies + Big Private Businesses

Ocean Thermal Energy Conversion

- To manufacture a 1MW level OTEC facility of commercialization module (2016-2017) and to test at a real-ocean test bed (2017-2018)
- To develop a system for seawater heating and cooling system of 1,000RT and then 2,000RT (2015-)
- To install and operate at the sea of Kiribati and to acquire the track record

Compound Offshore Energy

- To develop compound offshore energy technologies, which connect the offshore wind energy and wave energy until 2025;
- To develop an integrated control system of the floating-type offshore wind energy and wave power until 2016 and to test at a real-ocean test bed and to standardize the design until 2018

* Korean government has invested KRW15.2 bi to R&D for the floating-type offshore wind energy with the tidal power energy.

Renewable Energy Certificate

- Introduced Renewable Energy Portfolio Standard (RPS) in 2010

  – Electricity generation businesses should supply certain portion of renewable energy.

- Introduced Renewable Energy Certificate (REC)

  – Since September 2014, the REC weight value of 2.0 for the tidal power and current power has been assigned.

Renewable Energy Certificate

- General level of REC for the offshore energy is low compared with other renewable energy.
- Fourth New Renewable Basic Plan introduces a variable REC weight value to attract investment of the private business.

4.3 Revision of PWMRA

- Permit separately for the offshore energy generating facilities and the transmission line and associated facilities.
- To revise the PWMRA to clearly include both the offshore energy generating facilities and the transmission line and associated facilities in the object of permission, which then only one permit needs to be issued for the project of the offshore energy development.

4.4 Introduction of Marine Spatial Planning

- In 2009, introduced a zoning system in the coastal water zone
  - Usable area, Special area, Conservation area, Management area
  - No regulation on any prohibited, limited, allowable activities in the zoning areas
- No coordinating mechanism on the conflicts among multiple stakeholders at EEZ.
- Introducing a marine spatial planning (MSP) program to make up for limitation of the CZM program in the territorial waters and to effectively manage the EEZ

4.4 Introduction of Marine Spatial Planning

- To establish an information common use system,
  - To establish an Information Strategic Planning (ISP) until 2016,
  - To start the integration of information and data from 2017;
- To enact law and create organizations;
  - To conduct a basic research for enactment of MSP and feasibility of creating new organization in 2016,
  - To draft a MSP Act in 2017
  - To enact a MSP Act and to expand relevant organization until 2018

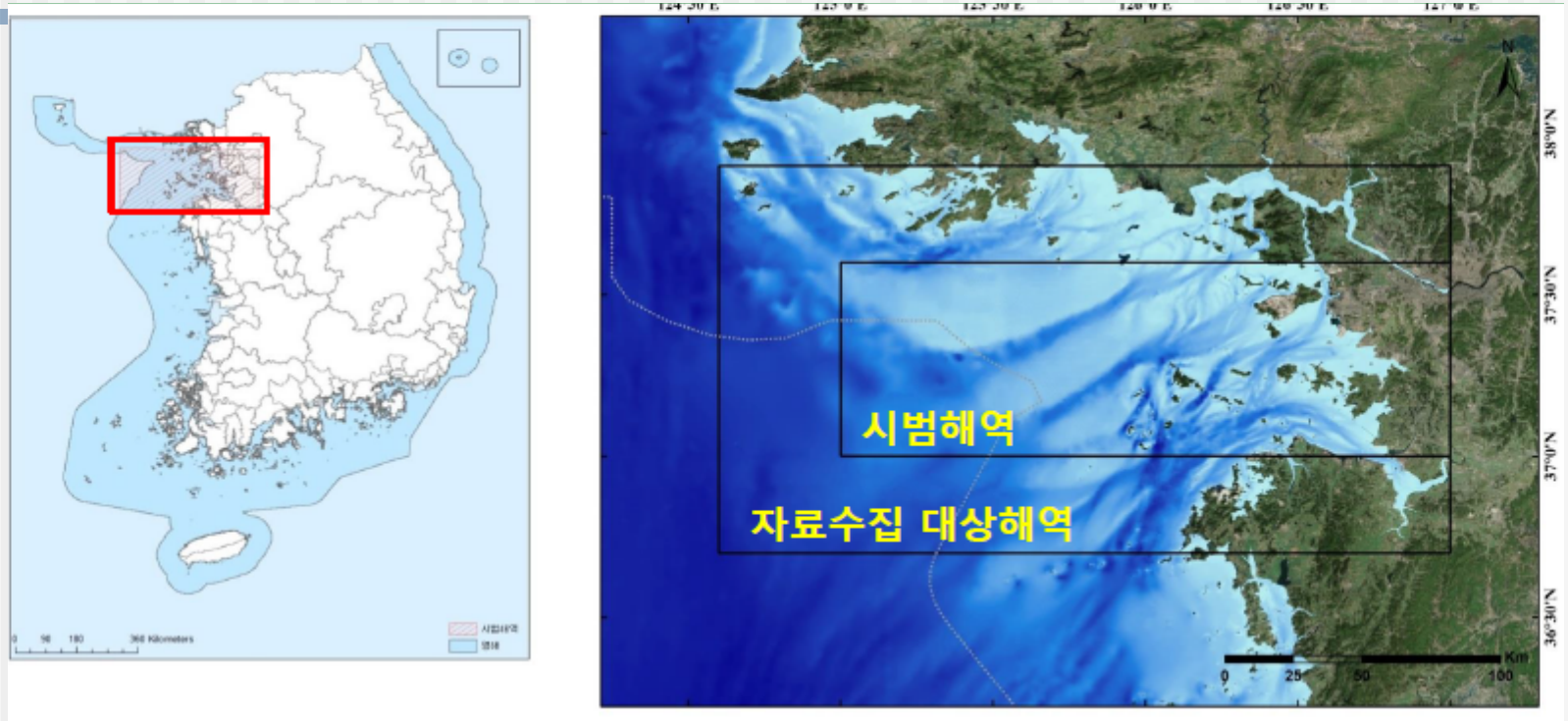
4.4 Introduction of Marine Spatial Planning

- To strengthen spatial managing tools,
  - To introduce a Marine Spatial Assessment System and a Marine Planning Assessment System until 2017,
  - To enact the Marine Spatial Assessment System and the Marine Planning Assessment System from 2018 to 2020;
- R&D for ocean spatial planning,
  - To carry out the basic research and secure budget in 2016,
  - To carry out R&D from 2017 to 2013;

4.4 Introduction of Marine Spatial Planning

- To carry out a pilot project
  - To review and analyze the spatial characters of the pilot site (part of EEZ and part of territorial waters of the Gyeonggi-do Province) in 2016,
  - Mapping of the spatial information of the pilot site in 2016,
  - To establish a Marine Spatial Information System for the pilot site in 2016,
  - To establish a draft MSP for the pilot site from 2016 to 2017
  - To develop a roadmap to extend the pilot MSP to the whole ocean area from 2016 to 2017;

4.4 Introduction of Marine Spatial Planning



4.4 Introduction of Marine Spatial Planning

- Public relation and outreach,
  - To form a social consensus and to strengthen international cooperation in 2016,
  - To announce MSP program and to implement public relation and outreach in 2017.

5. Conclusion

- Rich resources of offshore energy in the Korean waters
- Offshore energy development requires very high technologies due to very strong current, high tidal gab, and frequent typhoons

  - To be developed by investment of the government
- Private sector should be attracted to invest in the offshore energy industry with the technologies developed by the government.

5. Conclusion

- Not easy to attract the private businesses in the offshore energy industry
  - A large amount of investment under uncertain situation of success
  - Unfavorable institutional system compared with other renewable energy
  - Strong opposition from various stakeholders

5. Conclusion

- To establish a MSP program to coordinate conflicts among various stakeholders
- To revise relevant laws to make easy for the private businesses to develop the offshore energy in the public waters
- To develop institutional incentives such as variable REC value to attract private investment into the offshore energy industry.

- Thank you!