Offshore Energy: Taiwan Recognizes Opportunities and Challenges

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Today's Presentation

- Framing offshore energy issues for wind, wave and tidal energy
- US model and experience as a comparison point
- Offshore Wind in Taiwan
- Other Offshore Energy
- Into the Future

Framing the Issues

Context of Offshore Energy

- Although located offshore, strong ties to onshore issues, environment (ocean and greenhouse gas reduction), connection to the grid, costs, stakeholders, policy and politics
- Development of energy technology- both renewable and conventional require encouragement of investment; job development (off shore wind could support US 600K new jobs by 2050)
- Impact of ongoing deregulation of the power sector- competition in power generation and movement towards Smart Grid and new technologies
- Market transparency and data key components of change as well as multiple stakeholder support for changing energy dynamics

Revising an Energy Framework for Offshore Development

- Combining process and financial incentives
  - Offshore energy requires *clear, simplified and improved* permitting and financial incentives for development
- Siting often a controversial portion of any energy permitting process, particularly for offshore facilities
- Offshore development faces greater challenges
  - Offshore wind- cranes in hundreds of feet of water on enormous stilts; tower on steel foundation anchored to sea floor; blades need to withstand guts of 200 mph
  - Offshore wind operates at 45% of capacity factor so issues of reliability and capacity

US Legal Energy Framework

- Clear and separate roles for states and federal government raises issues of jurisdiction and regulation
- Regulation of land use and natural resources primarily with the states which then delegates to local governments
  - Results in a patch work of local ordinances, state and federal laws
  - Starting in 1970s states adopted “siting” laws to coordinate, expedite and streamline regulatory and licensing process for large scale power plants – threshold based on generation size
- Difficult to apply traditional siting to renewables since not large enough to qualify for expedited process; renewable development thus faces local approval which can be lengthy, costly and unpredictable; movement underway in many states to expedite permitting and siting for renewables (important for Taiwan to consider)

Over Arching Legal and Regulatory Framework

- UN Convention on the Law of the Sea governs use of oceans: territorial water up to 12 nautical miles/ territorial waters are sovereign territory of state and give full rights over water, sea bed and subsoil/ then exclusive economic zone extending up to 200 nautical miles from territorial sea baseline where a country possess rights to explore, exploit, conserve and manage the natural resources of the water column and seabed.
- Most ocean energy devises installed in territorial waters
- Legal and regulatory uncertainty are major issues to ocean energy deployment
  - in US more than 23 federal and state regulatory agencies involved in ocean energy projects
  - As this talk will show, multiple jurisdictions engaged and involved in offshore energy development
- Implications for National Security

US Framework and Experience

US Federal Legal Framework for Offshore Resources

- Over 60 years of legal framework
  - Submerged Lands Act (1953) gives states rights to natural resources no more than 3 nautical (5.6 kilometers) miles off coast
  - Outer Continental Shelf Lands Act (OCSLA) authorized DOI to lease submerged lands for economic development
  - Oil Pollution Act of 1990 gives authority for oil and gas pipelines
  - EPACT (2005) – for issue of leases on competitive basis

Bureau of Ocean Energy Management (BOEM) to manage OCS energy and resources in environmentally and economically responsible way

Complex, multistage process to acquire 25 year renewable energy lease to construct and generate electricity- BOEM ultimately decides whether or not to proceed competitively or not- offshore wind, ocean wave and ocean current

Example of MA BOEM wind lease -12 nautical miles offshore; awards competitive bids of 700,000 acres for $14.5 million- companies have 5 years to submit bids for approval

US Federal Tax Credits Key to Renewables

- Concept: Tax credits reduce the price at which energy sold- for wind impact between 22 - 50%
- Production Tax Credit applies to wind projects and originated under Energy Policy Act of 1992 and then lapsed in 1999; 2016 Omnibus Appropriations Bill determined planned phase out
- Cycle of expiration and reinstatement caused instability and uncertainty for investment

Federal Tax Incentives (2)

- PTC currently under planned phase out based on projects in construction:
  - 2015/16- full PTC of 2.3 cents/kwh
  - 2017 at 80% of full value
  - 2018 at 60% of full value
  - 2019 at 40% of full value

- Investment tax credit (ITC): orderly phase down (mainly for small wind)
  - 2015/16- full 30% ITC
  - 2017- 24% ITC
  - 2018-18% ITC
  - 2019- 12% ITC

Legal Framework for Renewables: Massachusetts as Example

- Requirements that load serving entities enter long term renewable contracts through competitive bidding processes to ensure competition and get the "best price"
- Establishment of "Green Communities" to reduce energy consumption and costs, reduce pollution, facilitate renewables and create jobs
- Net metering for solar which enables unused power to be sent back to grid at "fair" market price as opposed to feed in tariffs which are in place in Taiwan
- When energy goals set, then need processes in place for development-projects require certainty about process but not outcome
  - Creation of Energy Siting Board
  - Guidelines for permitting, coordination among regulatory agencies, hearings, need time limits for decision making and regulatory processes (delay is enemy of development)

Energy Development: Renewable Energy Certificates

- Renewable Portfolio Standards (RPS)- state establishes requirement that retail electricity suppliers purchase certain amount of power from renewables
- Tradable RE Certificates present proof that 1 MW of electricity has been generated from eligible renewable energy suppliers; prices depend upon year RECs generated, supply and demand system in state, type of power
- RPS system in 29 states has created REC Market; Mass early REC state
  - Determine what generating entities the RPS applies
  - Determine rate of increase of renewable generation over time
  - Both compliance and voluntary markets

Offshore Wind in Mass/NE: Case Study

- US technical offshore wind potential huge- 2000 GW; EU has 41 terawatt-hours of wind, accounting for only 1.5% of EU electricity production
- First US offshore wind farm operational in Rhode Island in May 2017-- 30 MW Block Island, Deepwater Wind with 5 GE turbines (589 feet tall); cost of $300 million; price 24 cents/kwh contrasted to 14 cents/kwh for RI average;
- MA “Act to Promote Energy Diversity” -2016- section 6 of chapter 25A MGL15-20 year contract for offshore wind project beyond 10 miles located in OCS
  - By 2017 distribution utilities required to solicit 1600 MW of offshore wind to be operative by 2027; staggered procurements of no less than 400 MW; procurements regulated by public utility commission;
    - transmission costs as part of bid but recovered through federal tariffs
    - Rules about long term contracts and the costs; rules about RECs and tracking of certificates

Renewables and Offshore Wind as Economic Development

- Offshore wind as greatest source of in state energy- thus a tool of and for economic development
  - Wind Technology Test Center- tests wind turbine blades
  - New Bedford Marine Commerce Center – to support of shore industry
- Key opportunities: stakeholder engagement, environmental characterization, metaocean data, *supply chain,* ports and infrastructure investment, work force development, transmission, research
- Endgame- creation of an offshore wind industry

Examples of Project Integration of Energy and Environmental Initiatives

Development of the New Bedford Marine Commerce Terminal

Benefits of the Port

- Creates a first-in-the-nation purpose-built facility to support assemble & construction of offshore wind project.
- Provides for construction of 1,000 foot long bulkhead capable of sustaining loads of 4,000 lbs/PSF.
- Provides New Bedford with new opportunities for heavy marine cargo.
- Significant increase in economic activity for Massachusetts & South Coast area.

Benefits: Environmental

- Removal of 244,600 cubic yards of contaminated sediments.
- Environmentally responsible disposal of contaminated soils.
- Creation of resource areas for winter flounder, shellfish, & wetland habitat.

Taiwan’s Offshore Opportunities

Taiwan’s Current Generation Mix

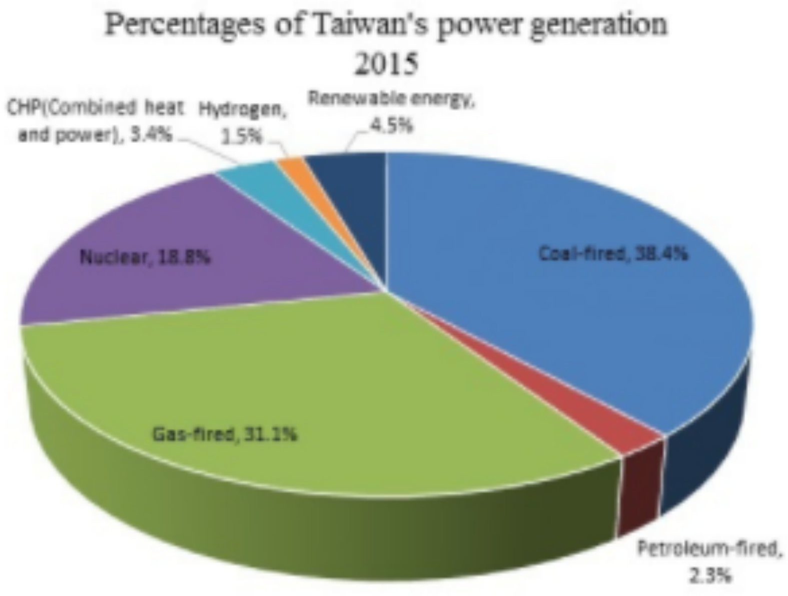


Figure 1 Taiwan’s electric power generation 2015 (Source: Taipower)

Potential Renewable Geography

Figure 2: Geography of targeted green energy development in Taiwan (Source: Green Energy and Environment Research Laboratories and compiled by the authors)

Taiwan's Energy Picture

- Taiwan total electric power capacity is 40 GW (compare US at 1000 GW or China at 1200 GW)
  - Generation Mix: Coal at 38.4%; LNG at 31.1%; Nukes at 13.8%
- Goal to be nuclear free by 2025 which completely alters energy direction toward alternative energy which means solar and wind- key issue
  - Goal to replace nukes with 20 GW of solar and 3 GW of offshore wind-
- 2015 GHG Reduction and Management Act calls for 50% emissions reduction by 2050, TEPA and Energy and Carbon Reduction Office (ECRO)
- Dependence on fossil fuels tied to security concerns but now energy security through renewable technology
- Renewable Energy Act (2009) – developers receive a 20 year PPA and FIT for offshore wind of 18.5771 cents/kWh

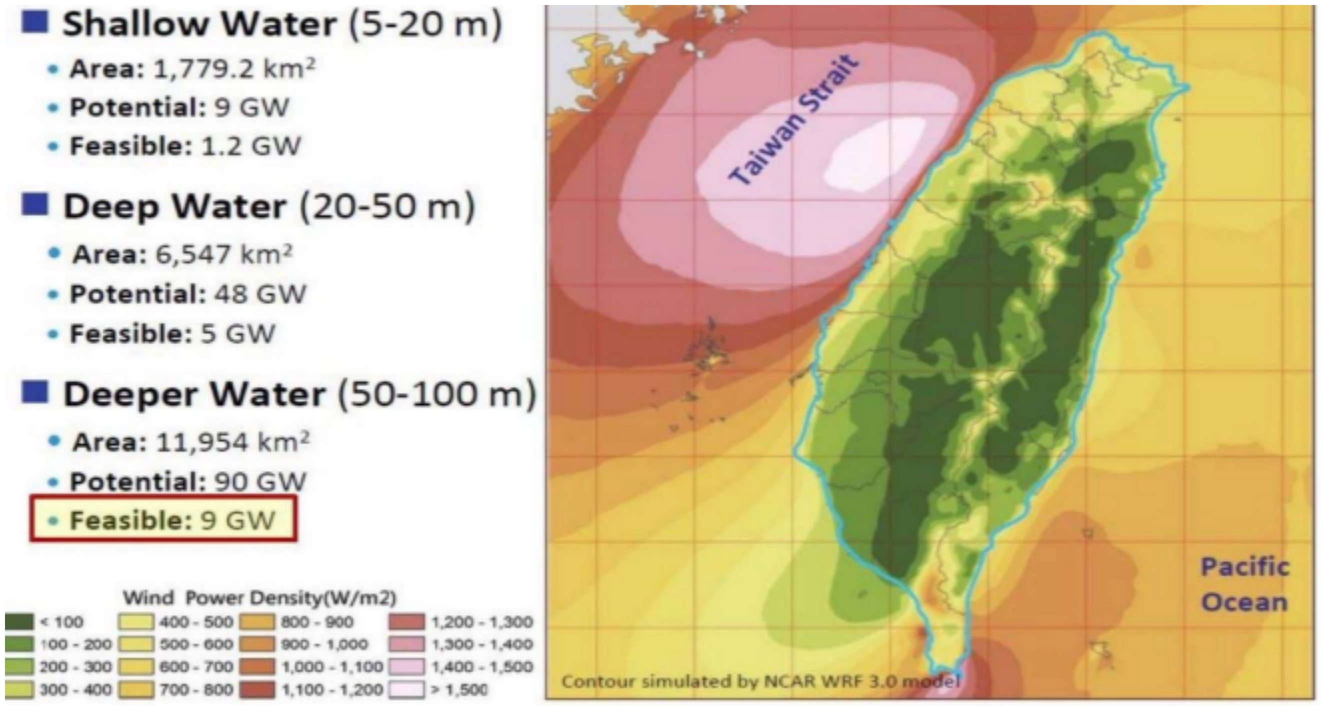
Taiwan's Articulated Green Energy Policy: Recognition of Multiple Aspects

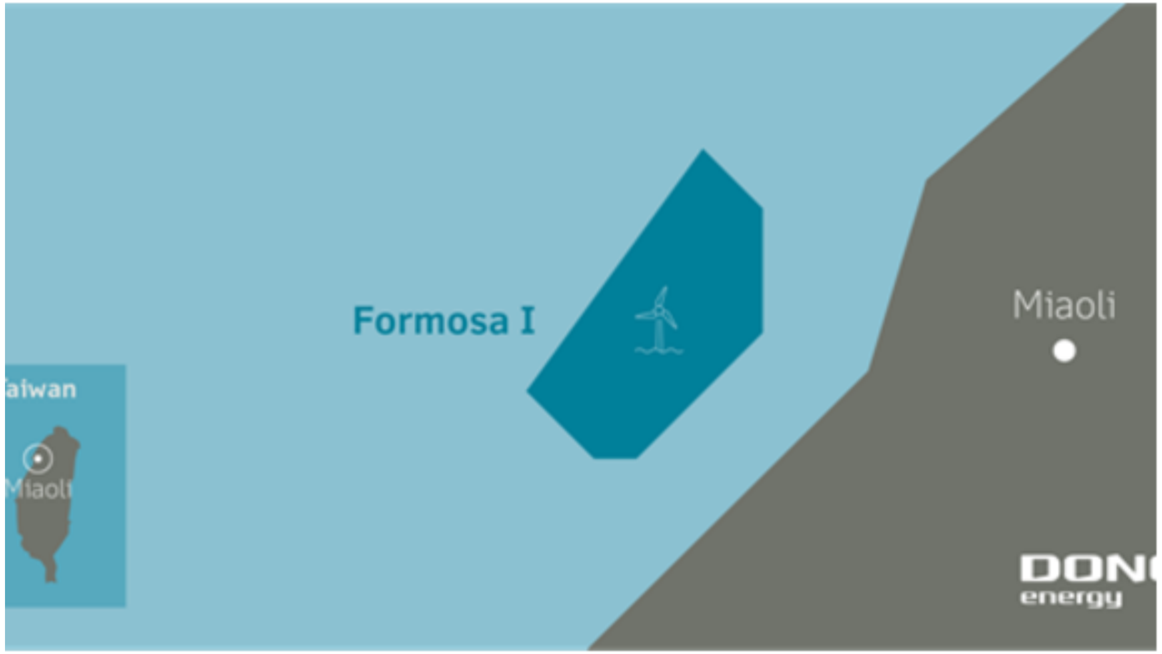
- Step One: Integration of talent, communication, innovation connecting corporate and academic talent – offshore wind energy in Taiwan Strait, solar in south, geothermal in east and ocean/ tidal in Pacific Ocean
  - Taiwan already world's largest producer of solar cells in 2015- providing nearly 20 % and also one of leading solar wafer and module makers although own internal market is underdeveloped
- Step Two: Increase green energy generation as a way to attract investment
- Step Three: Export green products and turn key renewable solutions into an increasingly green global market

Focus on Offshore Wind: Planning in Place

- Offshore wind recognized as Taiwan's most attractive renewable energy option
- Thousand Wind Turbines Project in Taiwan Straits, one of world's best offshore wind sites 2016-2030
  - 600 offshore turbines/450 onshore turbines- 4000 MW offshore by 2030
  - Three Rounds: One- *Initial Demonstration;* Two- *Potential Shallow;* Three- Commercial and Zonal Deepwater Development
  - Involves infrastructure construction, environmental assessments, fisheries compensation
- Role for government subsidies by FITs, loans and direct grants; incentives include 50% of installation expenditures

Taiwan Wind Potential (from Netherlands Trade and Investment Office)




Formosa I
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Current Taiwan Wind Projects

- FORMOSA I
  - Phase 1 two turbines of 8 MW installed in 2016/ Phase 2 120 MW to be installed in 2019 off Miaoli County in NW Taiwan
  - DONG (35%) as advisors, Macquarie Capital (50%) and Swancor (15%)for site development
- DONG's other investments – 4 offshore wind sites in Changhua for total capacity of 4 MW for construction 2012-2024
- Early stage collaboration with the Netherlands- proof of experience and recognition of opportunity

Recognition of Opportunities and Challenges of Collaboration with Foreign Companies

- Opportunities of Dutch and Danish
  - Beyond demonstration projects
  - Recognition of environmental issues - navigation, fisheries
  - Experience with engineering, project specific risk, marine construction
- Challenges
  - Typhoons and earthquakes
  - Specific environmental issues
  - Technology gaps
  - Financing issues
  - Location of wind farms

Opportunities for Marine Energy: Taiwan as Potential Testbed

Offshore Energy Opportunities

- Taiwan as island nation to look for other forms of offshore energy- tidal, wave, and current all of which in R&D or early prototype stage
- All renewable energy contributes to sustainable energy supply but are not environmentally friendly per se: Impact on the benthic community (ocean floor) due to alternations in flow patterns, wave structures, sediment dynamics; species-specific responses- will be affected by subsea cables, flow alteration. Sediment and habitat change near devices
- Challenges include technology development to prove robustness and reliability, to reduce costs, to deploy and to reduce risks

Fairly Recent Offshore Efforts

Table 1. Examples of ocean energy power systems developed in Taiwan

	Implementing agency	Configuration	Maximum output	Notes
Wave power	Industrial Technology Research Institute(ITRI)	Floating	20kW	Open Sea Test (2013) Output of 2.72 kW and efficiency of 31.4% against waves 0.8 m tall with wave energy of 8.65 kW
	Lisshan Co.,	Bottom-anchored	—	Tank Test
	National Taiwan Ocean University (NTOU)	Shore-anchored	0.8kW	Tank Test (2012)
Tidal power	National Taiwan Ocean University (NTOU)	Bottom-anchored	1.3kW	Open Sea Test (2012) Torpedo-like shape
	National Sun Yat-sen University (NSYSU)	Floating	5kW	Open Sea Test (2013) Float size: 6x7x5 mm
	Wanchi Steel Co.,	Anchored in the ocean	50 kW (Second generation)	Open Sea Test (2013) Generator within the rotors
	National Taiwan Ocean University	Anchored in the ocean	Principle currently being validated	System anchored in place and which consists of a set of two rotors
	National Taiwan University and National Taiwan Ocean University	Anchored in the ocean		

Source: Created from materials from the International Workshop on Marine Renewable Energy
http://www.classnk-rd.com/pdf/katsudou201408_C.pdf

Other Issues related to Ocean Energy, Development and Management

- Grid integration
    - Can be expensive due sub system and submarine cables; grid proximity to remove areas, grid development per se and variability of ocean energy- eg tides variable on an hourly basis, can be high while wave can be low and then great on a seasonal or annual basis; high costs to integrate with grid
    - Also issues of power quality like voltage control; thus converters and arrays will be important
- Installation, operation and maintenance
    - Will be expensive– up to 3.4-5.8% of capital expenditures compared to 2;3-3.7% for offshore wind
    - Array configuration is important- hydrodynamics and location will affect power output and costs
    - Operating in harsh environments

Socio Economic Impact of Early Stage Offshore Energy Projects

- How development rights affect society as a whole and local populations:
  - Employment, income and economic power
  - Visual impacts; impact on users of the ocean environment- measurement tools include budget, household income
- Social impact on new job creation v. negative impact on existing industries, both OPEX and CAPEX
  - Operational costs need to be estimated– grid connection, AV v DC transmission, offshore substation costs, cable costs, maintenance costs, energy losses

Moving into the Future

Offshore Marine Technology: Specific Technical Requirements for Taiwan

- Advanced Modeling should include competing uses of marine environment as fishing, shipping, offshore wind, habitat protection and grid connection
- Comprehensive Life Cycle Assessments of ocean arrays should include fluctuation of power output, storage, grid integration
- Grid integration studies need for power quality, area of control for potential cost reduction, spatial arrays
- Reformed legal and regulatory affairs to meet energy sector requirements and should define optimum stakeholder process

Offshore Energy: Key to Future

- Bottom Line: Offshore Energy should receive greater focus
- Clear implications for energy, environment, economic development, social context, grid integration
- Broad perspective: technology development and energy security
- Key implications for Taiwan in the global context
  - Offshore energy as conflict point or cooperation?
  - Broader security in reducing fossil fuel imports- coal, LNG, oil
  - Way to attract foreign investment, foreign partnerships
- Positive outcome in terms of bringing Taiwan out of isolation and a cleaner, technology driven energy future