Chapter 2

Harvesting Green Energy from Blue Ocean in Taiwan: Patent Mapping and Regulation Analyzing

Jui-Chu Lin and Wei-Ming Chen

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/64889

Abstract

Taiwan is an island with abundant oceanic resources but devoid of resources to significantly utilize ocean power. In fact, the Taiwanese government has initiated several renewable energy policies to transform its energy supply structure from brown (fossil fuel-based) sources of energy to green (renewable-based) energy. In addition, in the 4th National Energy Conference held in 2015, ocean energy was identified as a key contributor to renewable energy source. Therefore, the Taiwanese government proposed the construction of a MW-scale demonstration electricity plant, powered by ocean energy, as promptly as possible. Compared with solar PV, wind, and biomass (waste) energy, the development of ocean energy in Taiwan has lagged behind. Therefore, the aim of this chapter is to boost ocean energy adaptation using analysis from technical and legal perspectives. This chapter first illustrates the ocean energy potential and develop blueprint in Taiwan. Next, through patent research from the Taiwan Patent Search System, this chapter identifies advantageous ocean power technologies innovated by Taiwanese companies, primarily wave and current technologies. Furthermore, through the examination of regulations and competent authorities, this chapter discusses the possible challenges for implementing ocean energy technologies in Taiwan.

Keywords: ocean energy, renewable energy policy, patent mapping, Taiwan

1. Introduction

The oceans cover two-thirds of the Earth's surface and contain abundant available energy sources. In addition to its huge potential as an energy source, ocean energy is also inexhaustible, less polluting, and does not occupy terrestrial space, making it a renewable energy source with great development value. Taiwan is entirely surrounded by seas, with an area of maritime territory approximately 4.72 times that of its land territory [1]. The seas contain a wealth of natural resources, one of which is renewable ocean energy. Taiwan lacks domestic fossil fuel sources and has long been dependent on energy imports. A proper understanding of renewable ocean energy and its advantages followed by effective development of this resource could lead the country to its first step towards energy independence, as well as reduce its reliance on imported fossil fuel [2].

During the concluding session of the 4th National Energy Conference (NEC) held in 2015, developmental conditions of the country's territorial waters were considered before an ultimate goal was set, with the premise of marine environmental protection. The goal was to establish a commercial grade power plant by 2030 and to have a kilowatt (kW) grade demonstration power plant up and running as soon as possible. Separately, Taiwan has created the Sustainable Energy Policy Convention to address both the energy and the environmental challenges that it faces and has implemented energy conservation and carbon emissions reduction plans to reach the policy objective of achieving success in its management of energy sources, environmental protection, and the economy.

At the same time, many projects on the research and development of energy technologies have been planned and implemented, including the Program for the Research, Development, and Promotion of Energy Saving and Carbon Reduction Technologies and the National Energy Program [3]. In addition, pilot demonstration projects have been used as a means to comprehend crucial technologies, so that domestic industries could improve the self-production ratio of power generator units. The success of these projects has also been used to attract operators to invest in and develop related technologies [4].

2. An island with abundant ocean energy potential

The seas surrounding Taiwan hold abundant amounts of ocean energy. In its *White Paper on Technologies for Energy Industries 2014*, the Bureau of Energy (BOE) assessed the country's ocean energy sources and concluded that there is great development potential for power generation using ocean thermal energy conversion (OTE), wave energy, and ocean currents. These are briefly described below [2].

2.1. Currents

Sites for power generation using tidal currents must have potential energy greater than 1 kW/m^2. These sites are distributed in the territorial waters of Penghu (Pescadores Islands) and Northern Taiwan, with an estimated development capacity of nearly 200 MW.

In addition to tidal currents, the Kuroshio Current (black tide) generates an abundant water flow near the south and east coast of Taiwan. Four potential sites were identified based on the condition of a flow velocity greater than 1.2 m/s. The estimated development capacity for each site could reach 1 GW.

http://dx.doi.org/10.5772/64889

2.2. Wave energy

Eight potential sites were selected based on the following criteria: (i) wave energy greater than 10 kW/m, (ii) water shallower than 50 m, (iii) slope of the terrain less than 10%, and (iv) nonrestricted areas. The sites were mainly distributed in the country's northeastern corner and territorial waters of the Yunchang underwater ridge. Wave energy at the ridge was approximately 13.60 kW/m, which ranks second after Cape Santiago/San Diego (15.93 kW/m). The development capacity of Taiwan's wave energy has been estimated at 2.4 GW.

Currents	**S**	■ The Kuroshio Current passes Taiwan's peripheries with high flow velocities and volumes. ■ Annual average flow velocity off the coasts of Su'ao and Hualien, and at Green Island and Lanyu, is 1.2 m/s or more. ■ Potential capacity of power generators is at the grade of 1 GW.
	W	■ All sites suitable for development are located in waters deeper than 100 m and at a distance of 20 km or more from the coast. ■ Lack of long-term observed data.
	O	■ Overseas technologies to generate power using ocean currents have become more mature. Technological introduction can be considered.
Waves	**S**	■ Northeastern Taiwan has greater wave energy, of possibly 10 kW/m or above in offshore areas.
	W	■ Onshore equipment is easily damaged by frequent typhoons. ■ Higher technological requirements for offshore equipment.
	O	■ Development of wave energy technologies is reaching the standard for commercial use. Technological introduction can be considered.
OTE	**S**	■ Temperature difference between water at the ocean surface and 500 m depth in Taiwan's eastern and southern territorial waters can be 20°C or more, resulting in potential reserves of 30 GW. Capacity for power generating equipment is approximately several GW. ■ High-potential areas in the southeastern territorial waters are located nearer the coast.
	W	■ Efficiency of OTE needs to be improved. ■ Typhoon waves cause great damage to cold water pipes. ■ Taiwan's fundamental research on ocean energy sources is very limited.
	O	■ Alignment with the multi-objective use of deep seawater will create opportunities for the development of OTE.

Source: Modified from [2]

Table 1. Strengths, weaknesses, and opportunities for ocean energy development.

2.3. Ocean thermal energy (OTE) conversion

Nine potential OTE conversion sites are located in the east of Taiwan, based on the conditions of water shallower than 1000 m and a temperature difference larger than 20°C. Preliminary estimates have indicated that the development capacity of OTE power generation is 2.8 GW.

Table 1 lists the strengths, weaknesses, and opportunities of pursuing ocean energy in Taiwan. The common threats of different marine technologies are the natural limitations, including seafloor topography and climate. Especially, the stratum on the eastern side of Taiwan is slipping; the use of ocean energy faces severe challenges from the natural environment, including earthquakes and typhoons. In addition, the stage of global technology development is also a threat as well, countries that have been involved since the early stages of development have a better grasp of the crucial technologies for energy generation (including ocean currents, tides, waves, OTE, hydrated compounds, etc.). Therefore, it is necessary to in depth analyse Taiwan's advantaged ocean energy technologies, which will be illustrate in Section 4 of this chapter.

3. Blueprint for developing Taiwan's ocean energy

The Taiwanese BOE has not yet to include the ocean energy as a contribution of renewable energy source in the country's short- and medium-term (to 2030) promotion targets since the development of Taiwan's ocean energy technologies is still in the research and development stage (**Table 2**). It can be seen that the development of ocean energy occurs later compared to other renewable energy sources; however, the government drew an ocean energy development blueprint (**Table 3**) and intended to progressively develop ocean energy from the conceptual and verification stage to the development of small- to medium-scale systems, before proceeding to the development phase for large-scale systems and, eventually, commercial power plants [5].

Energy source	**2015**	**2020**	**2025**	**2030**
	Unit: MW			
Onshore wind energy	814	1200	1200	1200
Offshore wind energy	15	320	1520	3000
Hydraulic energy	2059	2100	2150	2200
Solar photovoltaic energy	842	2120	4100	6200
Geothermal energy	4	66	150	200
Biomass energy	745	768	813	950
Total	**4509**	**6574**	**9933**	**13,750**

Source: Ref. [2].

Table 2. Future promotion targets for renewable energy sources in Taiwan.

http://dx.doi.org/10.5772/64889

	2015	2018	2025	2030
Stage	**Testing and verification at sea**	**Large-scale systems development**	**Power plants Demonstration**	**Power plants Commercialization** (2035)
Technological milestone	Ocean energy system design and development [< 100 kW to several hundred kW]	Ocean energy system connection of power grid for electricity transmission [< 100 kW to several hundred kW]	Ocean energy demonstration power plants [1 MW]	Small-scale commercial power plants [10–30 MW]

Source: Modified from [5]

Table 3. Timeframe for ocean energy development in Taiwan.

In the ocean energy blueprint, the government plans to build a demonstrative wave generator for testing and verification purpose by 2018 and to connect the generator to the grid. Long-term testing and verification will provide the basis for rectifying and improving the design of the generator set, before the development of a commercial set is undertaken. The target is to complete the first 1 MW pilot demonstration plant in 2025 and to develop small-scale commercial power plants (30 MW) by 2030. There will be acceleration towards the full-scale development of commercial power plants by 2035, which will contribute to Taiwan's use of renewable energy sources to generate electricity [5]. However, as the beginning of 2016, the stage still stays on research and development. The plan of sea testing and verification, which was planned to implement by the end of 2015, was delayed because of typhoon.

Research is conducted, and development is fostered through technical cooperation undertaken jointly by academia and industry. The main undertakings are short-term testing at sea of power generators using tidal current. These include projects in the territorial waters of Keelung Sill by National Taiwan Ocean University and at the Penghu Bridge by Sun Yat-sen (Zhongshan) University, as well as the power generator system using ocean currents that was jointly researched and developed by Wanchi Steel Industrial Co., Ltd. and National Cheng Kung University.

4. Patent mapping and analysis

To understand the current development among Taiwan's industries regarding ocean energy technologies, so as to understand the current situation and characteristics of the relevant patents, a patents map is presented for an effective organizational analysis of patents information in this section.

4.1. Patent search and analysis procedures and methodology

The patent search and analysis procedures are as follows: first, to determine the subject; second, to collect and to review the relevant literature and public information; third, to develop patent search strategies and fourth, to draw patent map. The subject is to analyse marine technology development situation in Taiwan. Based on the review of the literature and relevant information, the ocean energy technologies were divided into two categories: (i) an analysis of types of ocean energy sources and (ii) a detailed study of the energy conversion methods used in each type.

As shown in **Table 4**, the types of ocean energy sources can be categorized as follows: (i) tidal energy, (ii) ocean currents, (iii) wave energy, (iv) ocean thermal energy (OTE), and (v) others (combined with wind energy or other sources). Among these categories, ocean currents and wave energy are currently mainstream develop in Taiwan [6–8][1] The energy conversion methods used by these two categories are shown in **Table 5** and can be preliminarily grouped into 15 methods. Thus, when performing the patent search and examining patents, both energy sources and conversion methods were considered so as to improve the degree of accuracy and rate of search returns.

Type	Description
Tidal energy	Potential energy difference between daily tidal fluctuations is used to generate electricity
Ocean currents	Ocean currents are used to drive hydraulic turbines for power generation
Wave energy	Potential energy difference, reciprocating force, or buoyancy difference caused by wave movements are used to generate electricity
OTE	Vaporized working fluid arising from temperature difference between deep and surface layers of seawater is used to drive turbines for power generation
Others	Various technologies are used, such as differences in salinity and auxiliary power from desalination equipment

Table 4. Types of energy sources used by ocean energy technologies.

Method	Description
(*i*) *Wave energy*	
Bellows	Buoys pushed by waves drive the bellows to pump air. The air is stored inside regulated storage barrels and is steadily released to drive the generators
Point absorber	Buoys are used to convert the potential energy difference, reciprocating force, or buoyancy difference caused by up-down movements of waves to mechanical energy. Depending on the installation method, the point absorber is either fixed or floating
Lever	Buoys are connected to a lever, which converts the potential energy difference, reciprocating force, or buoyancy difference caused by up-down movements of waves to mechanical energy

[1] The mainstream applications in Taiwan were not clearly stated in any single literature. However, most research papers and national policies were more frequent mentions of power generation using ocean currents and wave energy.

Method	Description
Oscillating wave surge converter	Dampers with reciprocating strokes are used to withstand the kinetic energy and impact of forward and backward movements, which are then converted to mechanical energy
Rotating mass	A mass is installed at an off-center location within the buoys. The up-down and left-right movements of waves cause the mass to rotate within the buoys, thereby generating mechanical energy
Attenuator	Buoys are aligned perpendicular to the waves. The up-down movements of waves cause the buoys to move along the axis. Mechanical energy is generated after applying selective and appropriate restrictions
Bulge wave	This is similar to the wave attenuator method
Oscillating water column	A device with a hollow structure is partially submerged in water with an opening beneath the water level. The hollow structure traps air that is above the water level. When the waves move, the surface of the water column within the device rises and falls, thereby compressing and expanding the internal air column. This drives the turbine and, in turn, the generator to produce electricity. The device is designed in such a way that regardless of air flow direction, the generator will rotate in a similar direction
Overtopping/ terminator device	Waves are used to capture the water reservoir stored between the surface and the depths of the sea. The water is then released with gravity, turning the turbine underneath to generate electricity. This type of device generally uses a collector to gather wave energy
(*ii*) *Ocean currents*	
Enclosed tips (Venturi)	A large conduit with openings is used to collect large amounts of ocean current energy. The highly efficient beam shrinkage effect is used to pass the collected ocean currents through a turbine generator installed within the conduit, which converts them to electrical energy
Horizontal axis turbine	Ocean currents cause underwater turbine blades to rotate, converting the fluid's kinetic energy to mechanical energy. Its unique characteristic is that the direction of the rotation axis is parallel with ocean currents
Vertical axis turbine	Ocean currents cause underwater turbine blades to rotate, converting the fluid's kinetic energy to mechanical energy. Its unique characteristic is that the direction of the rotation axis is perpendicular to ocean currents
Oscillating hydrofoil	This is comprised of a hydrofoil, oscillating boom, and hydraulic device. Tidal flows on both sides of the hydrofoil cause the boom to sway. The oscillating boom causes the high-pressure fluid to flow, driving the turbine inside the high-pressure flow system to generate electricity
Turbine	Large turbines are directly installed at the bottom of the ocean. Currently, this method is often combined with the conduit method
Tidal kite	A turbine is mounted on a submersible buoy, which is submerged below the water surface and installed in the direction of the ocean currents to capture the currents' kinetic energy

Table 5. Energy conversion methods used by ocean energy technologies.

To ensure comprehensiveness and completeness of patent search and analysis, a large-scale search of all relevant patents within the field was conducted using Taiwan's database on patent information.[2] Keywords with general meanings were used for searching, including the Chinese characters for "ocean/marine," "current," "wave," "tidal," "tide," "temperature," "thermal," "converter," "conversion," "salinity," "electricity," and "power generation". The returned results were checked for technical terminologies and natural language used in patents for power generation technologies using ocean energy. The keywords were then redefined for a subsequent search so as to exclude irrelevant patents and improve the rate of return for relevant patents. Other parameters used for the patents search are summarized in **Table 6**.

Parameter	**Details**
Company	Not specified
Region	Republic of China/Taiwan
Period	1990 to September 11, 2015
Fields	Summary of patent specifications
Browsing and filtering fields	Patent name, summary, diagrams
Language	Chinese
Database	Public database on Taiwan patents
Keywords	Ocean, marine, wave, tidal, tide, current, temperature, thermal, converter, conversion, salinity, electricity, power generation
Syntax	(Ocean OR marine OR wave OR tidal OR tide OR current OR temperature OR thermal OR salinity) @AB AND (power generation) @AB OR (wave AND energy) @AB OR (wave AND conversion) @AB

Table 6. Parameters in search for Taiwan's patents in marine power technologies.

4.2. Life cycle analysis of patented technologies

For the life cycle analysis, the development of patented technologies is divided into the following stages based on the number of patent applications: (i) emerging, (ii) growth, (iii) maturity, and (iv) decline [9]. The actual life cycle (**Figure 1**) is derived by plotting the number of patent applications or number of patentees under publication of application per year against the number of granted patents.

In **Figure 1**, the emerging stage is indicated by the portion of the curve that is gently rising. Willingness of companies to invest in the technology is low, while the number of patent applications and patentees are small. The curve rises sharply during the second stage, in which there is a technological breakthrough or companies have cognition of the technology's market value and compete to invest in its development. Consequently, the number of patent applications and patentees rapidly increase.

[2] Taiwan Patent Search System (http://twpat5.tipo.gov.tw/tipotwoc/tipotwkm). Agency: Intellectual Property Office, MOEA. Date of search: September 16, 2015. Scope: (i) granted patents (summary) for 1990 to September 11, 2015; and (ii) publication of applications (summary) for May 1, 2003, to September 11, 2015.

During the third stage, the curve rises upward almost vertically, indicating that companies are no longer investing resources in research and development of the technology. Only a minority continues to develop this type of technology, whereas other companies exhibit a low level of willingness to enter the market. The growth in the number of patent applications and patentees gradually declines. At the fourth stage, the curve bends backwards, indicating the industrial technology has reached a bottleneck that is difficult to break through. Another possibility is that the industry has become over mature; hence, there is negative growth in the number of patent applications and patentees.

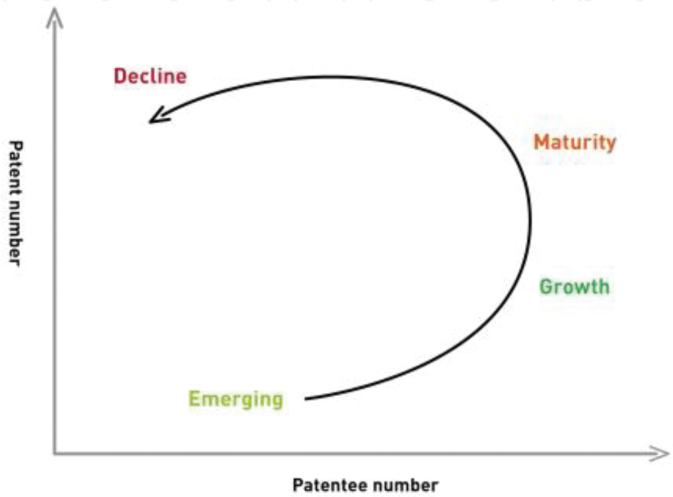

Figure 1. Life cycle of patented technologies [9].

The life cycle of Taiwan's patents in ocean energy technologies according to the year of the grant and the publication of the application are shown in **Figures 2** and **3**, respectively.

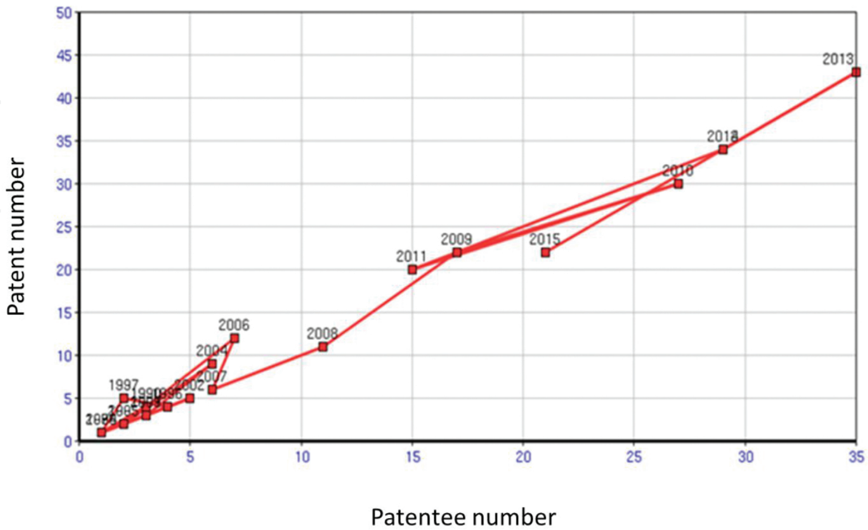

Figure 2. Life cycle of patented technologies for marine power generation according to year of grant.

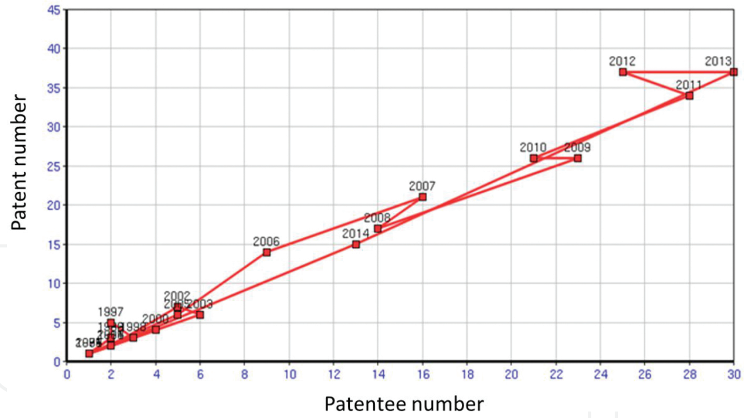

Figure 3. Life cycle of patented technologies for marine power generation according to year of publication of application.

The curves in **Figures 2** and **3** indicate that the development of Taiwan's patented technologies in marine power is moving from gradually to rapidly rising.[3] In other words, the development is between the emerging and the growth stages with considerable development potential.

4.3. Analysis of patented technologies based on annual number of applications

Taiwan's annual number of patent applications for ocean power generation is shown in **Figure 4**. **Figure 4** indicates the annual number of patent applications and granted patents, which have been increasing every year. With increasing awareness of green energy and guidance from government policies, the trends in relating inventions, researches, and development have correspondingly increased. This further proves that there is great development potential for marine power technology in Taiwan.

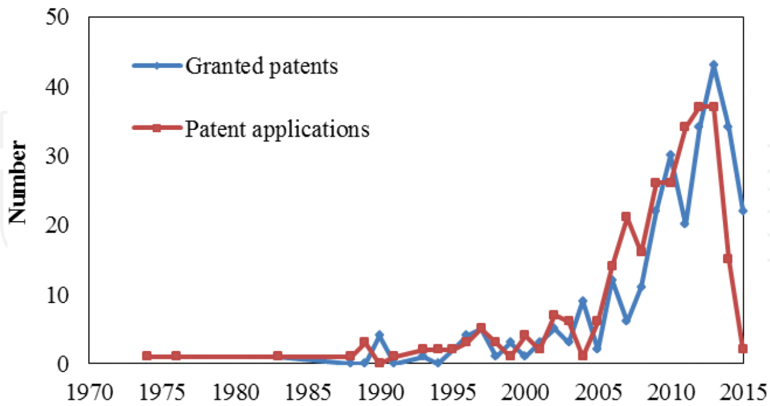

Figure 4. Annual number of patent applications for marine power generation (see Footnote 3).

[3] The patent search results showed in **Figures 2–4** include utility model patent and invention patent (not include design patent). Because utility model patent review requires 2–6 months and invention patent review takes 18 months from application to be openly revealed in the patent system, and this patent search was conducted in September 2015. Therefore, the numbers of 2014 and 2015 only include partial cases.

4.4. Nationality analysis of first applicants for patented technologies

The nationalities of the first applicants for Taiwan's patented technologies in marine power generation are shown in **Figure 5**. It can be seen that the relating patents were mostly Taiwanese research and development efforts. There are few foreigners applying for patents in Taiwan, which means they have not been actively applying for relating patents in the country. Such a patent distribution indicates that the Taiwanese have an opportunity to seek crucial technologies from patents in other countries and to adapt these technologies to Taiwan's oceanographic environment. Research and development in this area will facilitate the development of localized technologies for marine power generation.

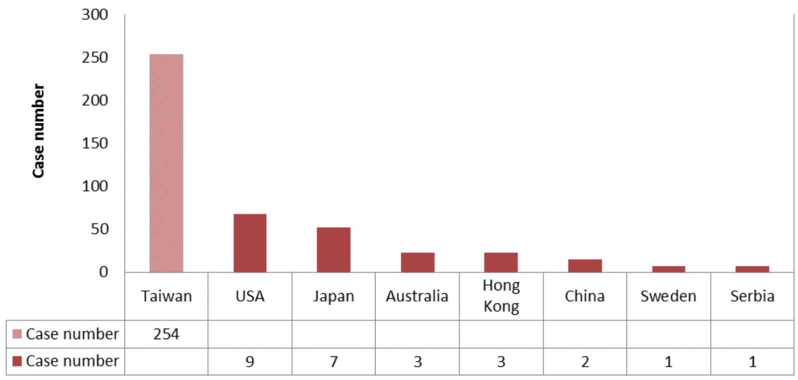

Figure 5. Nationality of first applicants for patents on marine power generation.

4.5. Analysis of patented technologies based on energy source

The patent distribution of different types of ocean energy is shown in **Figure 6**. The majority of patents made use of wave energy, followed by ocean currents. The Kuroshio Current along the east coast of Taiwan is stable while the waves at the territorial waters northwest of Penghu can generate power up to 15–20 kW/m. Thus, the development of relating technologies in Taiwan has capitalized on the unique characteristics of its geographical environment. In

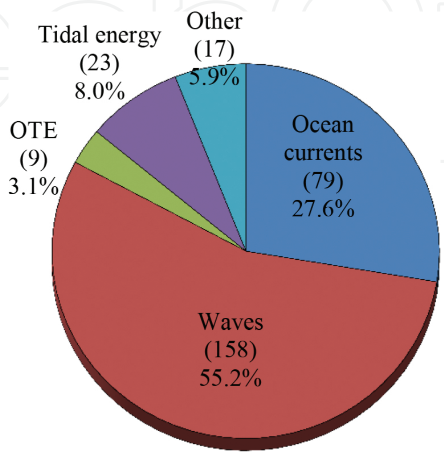

Figure 6. Distribution of patents on marine power generation based on energy source.

contrary, because of Taiwan's relatively short coastline and vast geographical disparities between its east and its west coasts, these features do not facilitate the development of power generation using differences in temperature or salinity [10].

4.6. Analysis of patented technologies based on energy conversion method

Since wave energy and ocean currents are the main types of ocean energy in Taiwan, the methods used for converting the energy supplied by the waves and currents to mechanical energy, which is then converted to electrical energy was identified. Subsequently, the patent distribution was analyzed. Patent summaries and diagrams that made use of wave energy were screened, and the distribution is shown in **Figure 7**.

The largest proportion (33.1%) of methods used the point absorber (both fixed and floating types), followed by the oscillating wave surge converter (18.4%). Other conversion methods accounted for 19.6% and included a combination of wind, tidal, and other forms of energy. There were also patents involving the use of various platforms (ship-like, load-bearing, and matrix) to stabilize the waves or enlarge the energy capture area.

Wave energy basically harnesses the up-down movement of waves. The kinetic energy of waves is converted to electrical energy through a steady-motion mechanism. Currently, the main developmental type used by most countries globally is the point absorber. Considering the conditions of the territorial waters and energy needed for construction, the Taiwanese BOE selected floating point absorber (FPA) as key technology for further development [11].

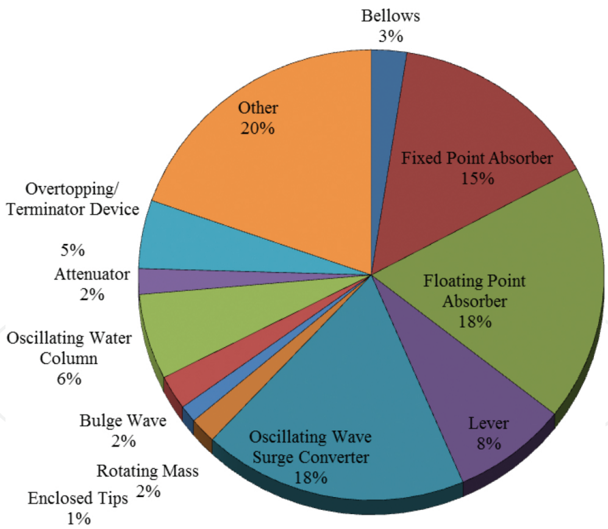

Figure 7. Distribution of patents based on energy conversion methods for wave energy.

The distribution of energy conversion methods for ocean currents is shown in **Figure 8**. The method with the largest proportion (41.8%) involved a spindle with blades, which rotate and drive the power generating device. This method was further separated into radial and axial types (26.6% and 15.2%, respectively). The next highest proportion was the underwater kite (including the addition of a mounted device suspended to face the direction of the ocean currents), which accounted for 15.2%. Although the "other" category totaled 35.4%, this in fact comprised multiple and dispersed types of patents, including the use of friction between ocean currents and metals for electrification, the combination of wind energy and sailboats, and a power generation system using a regulator rectifier module.

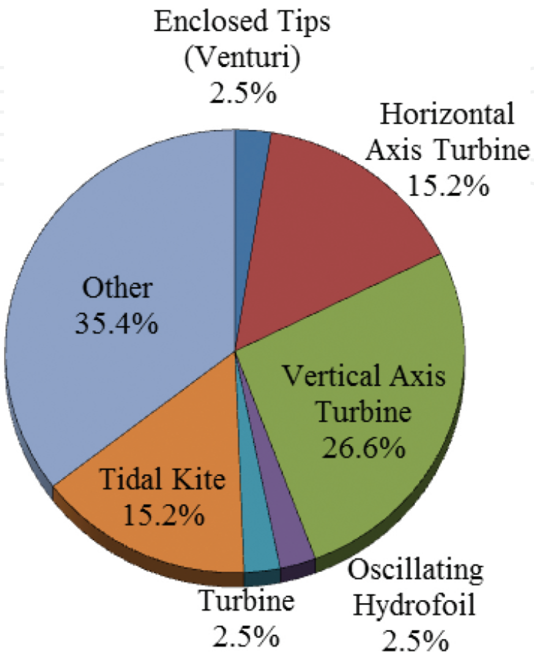

Figure 8. Distributon of patents based on energy conversion methods for ocean currents.

The Kuroshio Current passes the regional seabed off Taiwan's east coast. However, the waters there are very deep, making marine engineering far more difficult compared to power generation using wave energy. The construction and maintenance costs are also much higher. The lack of basic observed data on the Kuroshio Current also means that there is insufficient reliable information. In terms of Taiwanese patents for marine power technologies (**Figure 6**), although the number for power generation using ocean currents ranked second at 27.6%, it is still almost 30% fewer than those using wave energy. Hence, the BOE is studying and planning to build a to-scale ocean current model for Taiwan in order to evaluate the potential use of the Kuroshio Current [7]. The findings will serve as the basis for developing power generation technologies using ocean currents, which will contribute to the planning of a development blueprint.

5. Regulations and comptent authorities

Patent analysis result shows that Taiwan's ocean energy technologies are emerging and growing, especially wave and current technologies. To develop ocean energy technology, the government plays a crucial role in the early stages of development because ocean energy cannot be progressively developed from onshore to offshore, meaning that operators who invest in ocean energy have to bear much higher risks. In addition, legal and regulatory issues are continually cited as a major nontechnical barrier to the development of ocean energy [12]. Consenting is also generally regarded as a major nontechnological barrier to the progress of the marine renewable energy industry due to the complexity of the processes. Numerous licensing authorities, the lack of dedicated legal frameworks of the process, stakeholders for statutory consultation, mandatory EIA and the time scale that would possibly delay the privates entering the market in an early stage [13]. Therefore, to facilitate ocean energy development, this section identifies core issues, relating regulations, and competent authorities.

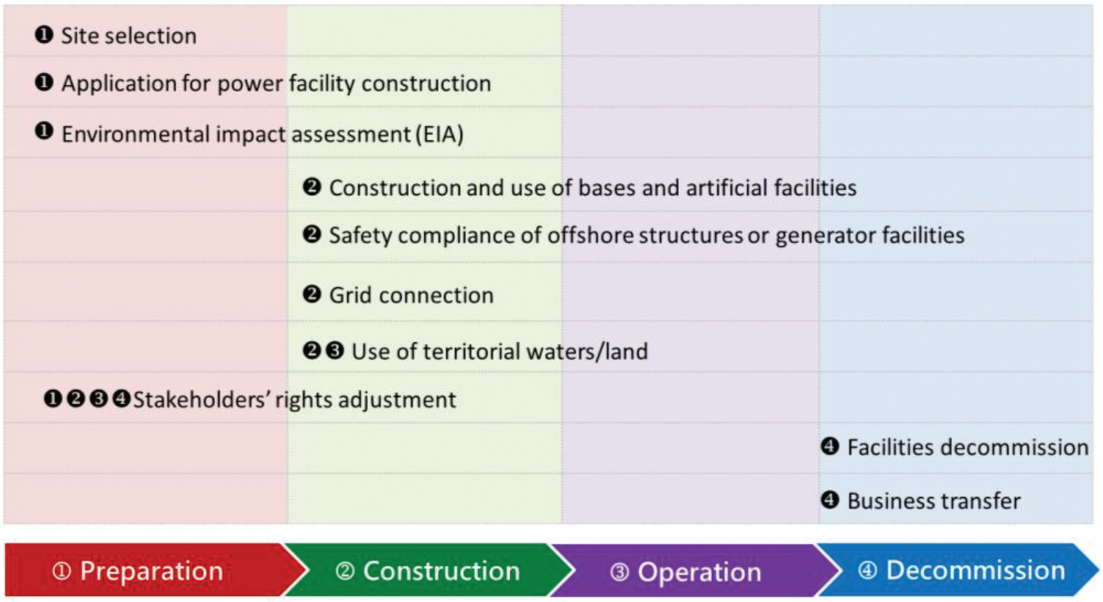

Figure 9. Core issues of deploying ocean energy based on four stages.

Core issues of ocean energy deployment are identified and listed according to four stages of deployment, i.e., preparation, construction, operation, and decommission (**Figure 9**). In the preparation stage, the operators have to select site, conduct environmental impact assessment, and prepare application documents. In the construction stage, the use of bases and artificial facilities, safety compliance of generator facilities, and grid connection are main issues. In the operation stage, the use of territorial waters and land has to be clarified. In addition, the stakeholders' rights adjustment is a crucial challenge. In fact, the rights issue (especially fishery right) has been raised in Taiwan for offshore wind energy development. In the decommission stage, the facilities decommissioning and electricity business transfer are key issues.

Once the core issues affecting the development of ocean energy industry are defined, the next step is to further examine relating legislation and competent authorities. Basically, legislation related to ocean energy development include Renewable Energy Development Act, Coastal Act, Electricity Act, Electricity Business Registration Rules, Fisheries Act, Environmental Impact Assessment Act, and so forth. Competent authorities of ocean energy are Ministry of

http://dx.doi.org/10.5772/64889

Economic Affairs (MOEA),[4] Ministry of the Interior (MOI), Council of Agriculture (COA), and Municipality or county (city) government. **Table 7** presents six issues and relating legislation and authority, as well as detailed questions for each issue.

Legislation	Competent authority	Issues
i. Application for power facilities construction		
• **Renewable Energy Development Act** • **Electricity Act** • **Electricity Business Registration Rules** • **Coastal Act**	• National: ○ MOEA • Local: ○ Municipality or county (city) government	• It is unclear whether local governments have jurisdiction over matters relating to territorial waters. Hence, it is doubtful that they should be appointed as the competent authority
ii. Use of territorial waters/land		
• **Renewable Energy Development Act** • **Law on the Territorial Sea and Contiguous Zone** • **Law on the Exclusive Economic Zone and Continental Shelf** • **Licensing measures for the construction, use, modification, & demolition of facilities/structures on artificial islands within the exclusive economic zone and continental shelf** • **National Property Act** • **Regional Planning Act** • **Coastal Act** • Ministry of the Interior (MOI) • Is the scope of usable territorial waters similar to that of off-shore wind power generation systems? • Does the central government have overall ownership rights of the territorial waters?		

[4] Bureau of Energy is under the Ministry of Economic Affairs

Legislation	Competent authority	Issues
What is the procedure for use of those waters? • Does the perspective of managing state-owned properties apply? Can leasing be arranged? • Are the bases for setting up power generators and equipment treated as facilities/structures on artificial islands?		
iii. Site selection		
• **No related statutes or provisions.** • **Need to consider the natural and social conditions, as well as make relevant changes to the rights holder.** • **Freedom of Government Information Act**	• Relevant authority for application and setting up procedures	• Relevant laws do not include the procedure to select sites for renewable energy power generators and equipment. Operators currently select sites on their own. However, public authorities should intervene, incorporate information disclosure and mechanisms for public participation • Local governments have to work with local self-governing bodies for the survey/assessment of sites
iv. Stakeholders' rights adjustment		
• **Renewable Energy Development Act** • **Fisheries Act** • **Shipping Act**	• Council of Agriculture (COA) • Ministry of Transportation and Communications (MOTC)	• Compensation under Article 29 of the Fisheries Act does not provide for development relating to renewable energy • Compensation is not stipulated under the Shipping Act • Local governments' obligation to assist in coordination between applicants and relevant rights holders is not clearly stipulated

Legislation	Competent authority	Issues
		• Need to compile case studies of successful agreements, with public disclosure of information
v. Safety compliance of offshore structures or generator sets		
• **Licensing measures for the construction, use, modification, and demolition of facilities or structures on artificial islands within the exclusive economic zone and continental shelf** • **Commodity Inspection Act** • **International certification standards**	• MOI • Bureau of Standards, Metrology, and Inspection	• Need to establish certification standards that comply with international technical standards
vi. Environmental impact assessment (EIA)		
• **EIA Act** • **Article 29, Item 1, No. 8 of "Details and scope identification criteria for development activities that shall conduct EIA" are to be implemented.**	• Competent authority for target business • Competent authority for EIAs (may be under the national or local authority, depending on target business)	• The competent authority for the target business of applying for/setting up of ocean energy power generators and equipment should be determined • Specifications for the review of ocean energy EIAs should be established

Table 7. Taiwan's legislation and competent authorities for the ocean energy industry.

6. Conclusion

Taiwan is an island with abundant ocean energy potential. Although ocean energy has not been identified as a contribution to energy supply component in the short- and medium-term (to 2030) promotion targets, the government has drawn a blueprint and set up timeline for ocean energy development.

Presently, Taiwan's patented technologies on ocean energy have passed the emerging and the growth phases. The number of patent applications made each year has been increasing, with the majority of applicants being Taiwanese. Most of the applications have involved the use of wave energy, with the predominant energy conversion method of fixed or floating point absorbers. The BOE has also selected the floating point absorber system as a major development project [11]. This indicates that the government's policies are in line with developments by private industries and that a unified, major investment direction has been established. Therefore, the development of ocean energy in Taiwan has substantial potential.

In addition to reviewing technology development status, identifying technologies with developing opportunities, examining regulations and the relevant competent authorities, the government must also looks to the future and promote the development of industries relating to ocean energy through demonstration projects, policy guidance, incentives, and other strategies (such as joint development with offshore wind energy). In doing so, the abundant ocean energy resources can be tapped, thereby enhancing Taiwan's degree of energy independence and promoting the localization of Taiwan's renewable energy industry.

Acknowledgements

This chapter is supported by the Ministry of Science and Technology (MOST), Taiwan, under National Energy Program Phase II (Grant no. MOST 105-3113-f-011-002). The authors like to acknowledge the enormous support from the members of the Law and Technology Innovation Center at the National Taiwan University of Science and Technology, especially thank Tsung-Ying Hsieh, Chia-Hung Liu, and Yu-Wen Peng.

Author details

Jui-Chu Lin[1] and Wei-Ming Chen[2*]

*Address all correspondence to: kattyouth@gmail.com

1 College of Intellectual Property Studies, National Taiwan University of Science and Technology, Taipei, Taiwan

2 Center for Applied Demography and Survey Research, University of Delaware, Newark, Delaware, USA

References

[1] Shyu CT. Geology of the Soils and Rocks of Taiwan's Mountains [Internet]. 2010. Available from: http://twgeoref.moeacgs.gov.tw/GipOpenWeb/imgAction?f=/2010/20102268/0001.pdf [Accessed: 2016-01-15]

[2] He WJ, editor. White Paper on Technologies for Energy Industry 2014. Taiwan: Ministry of Economic Affairs, Bureau of Energy; 2014. Available from: http://web3.moeaboe.gov.tw/ecw/populace/content/SubMenu.aspx?menu_id=2324 [Accessed: 2016-01-15]

[3] Ministry of Economic Affairs, Bureau of Energy. White Paper on Technologies for Energy Industry 2012. Taiwan: Ministry of Economic Affairs, Bureau of Energy; 2012.

Available from: http://web3.moeaboe.gov.tw/ECW/populace/content/SubMenu.aspx?menu_id=62 [Accessed: 2016-01-15]

[4] Ministry of Economic Affairs, Bureau of Energy. The Concluding Report. In: Proceedings of the 4th National Energy Conference; 26 January 2015; Taipei. Taiwan: Ministry of Economic Affairs, Bureau of Energy; 2015.

[5] Lin TC. Using the Oceans to Generate Power: A Sustainable and Flowing Energy Source that Remains Unexplored. Energy Monthly. 2015; December: 17–21. Available from: http://energymonthly.tier.org.tw/cnt.asp?issue=201512&page=17 [Accessed: 2016-01-15]

[6] Qiu RK. Energy and Sea: Introduction of Domestic Institutions for Marine Research. Energy Monthly. 2003; July: 27–29. Available from: http://energymonthly.tier.org.tw/outdatecontent.asp?ReportIssue=200307&Page=27 [Accessed: 2016-01-15]

[7] Zhang WQ, Yan ZW. Exploration of Domestic Marine Energy Development. Energy Monthly. 2010; August: 5–7. Available from: http://energymonthly.tier.org.tw/outdatecontent.asp?ReportIssue=201008&Page=5 [Accessed: 2016-01-15]

[8] Ministry of Economic Affairs, Bureau of Energy. Developing 20 KW Generating Unit: To Capitalize Marine Energy. Energy Monthly. 2014; October: 2–3. Available from: http://energymonthly.tier.org.tw/outdatecontent.asp?ReportIssue=201410&Page=2[Accessed: 2016-01-15]

[9] Hong YJ. Membrane Electrode Assembly (MEA) for Proton Exchange Membrane Fuel Cells: Patent Map and Patent Analysis. In: Proceedings of International Workshop of Fuel Cells; 22–23 September 2005; Taoyuan. Taoyuan: Yuan Ze University; 2005. Available from: http://goo.gl/BnMP19. [Accessed: 2016-01-15]

[10] Lu SM. Assessment of Developing Wave Energy in Taiwan. Science Development. 2015; 508: 56–59. Available from: http://ejournal.stpi.narl.org.tw/NSC_INDEX/Journal/EJ0001/10404/10404-09.pdf [Accessed: 2016-01-15]

[11] Ministry of Economic Affairs, Bureau of Energy. New Marine Energy: Technology of Floating Point Absorber. Energy Monthly. 2015; July: 8–10. Available from:http://energymonthly.tier.org.tw/outdatecontent.asp?ReportIssue=201507&Page=8 [Accessed: 2016-01-15]

[12] Wright G, O'Hagan AM, de Groot J, Leroy Y, Soininen N, Salcido R, Castelos MA, Jude S, Rochette J, Kerr S. Establishing a legal research agenda for ocean energy. Marine Policy. 2016; 63; 126–134. doi:10.1016/j.marpol.2015.09.030

[13] Simas T, O'Hagan AM, O'Callaghan J, Hamawi S, Magagna D, Bailey I, Greaves D, Saulnier JB, Marina D, Bald J, Huertas C, Sundberg J. Review of consenting processes for ocean energy in selected European Union Member States. International Journal of Marine Energy. 2015; 9: 41–59. doi:10.1016/j.ijome.2014.12.001

IntechOpen