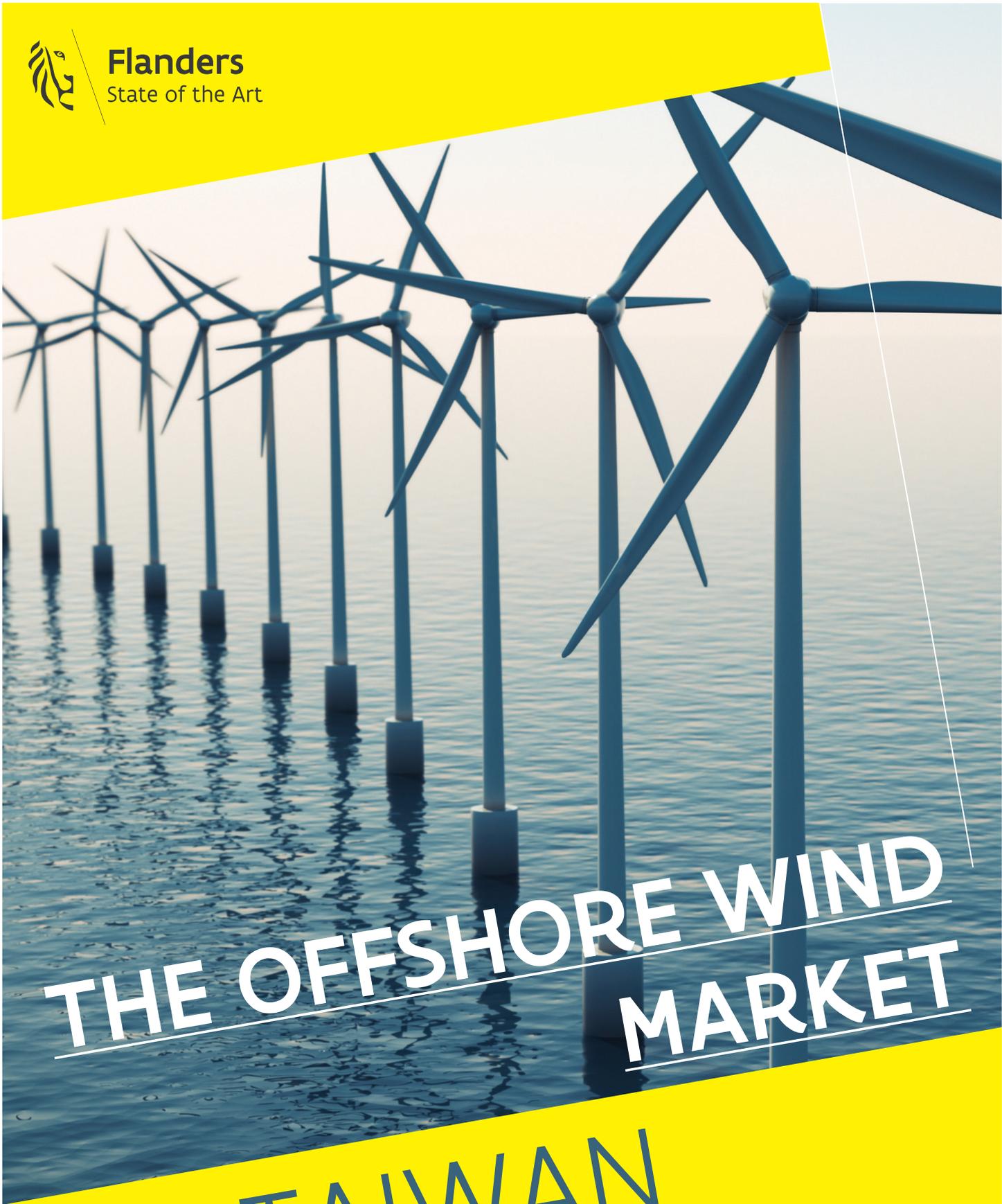




**Flanders**  
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# THE OFFSHORE WIND MARKET

## IN TAIWAN

FLANDERS INVESTMENT & TRADE MARKET SURVEY





**Flanders**  
State of the Art

# The Offshore Wind Market in Taiwan

April 2017

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**FLANDERS INVESTMENT & TRADE**



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## 1 INTRODUCTION

Taiwan is an island that highly relies on imported energy (97~99%) to sustain the power supply of the country. Nuclear power was one of the solutions to be pursued to resolve the high dependency of the country to fossil-fired power but the government has been facing the public opinion to adjust the energy policy after the Fukushima incident. Since the public's confidence towards nuclear power has been shattered, renewable energy has now become the new hope of the country towards the new low-carbon and less-import-dependency energy portfolio for next decades.

The Tsai Ing-wen administration, taking office since May 2016, has vowed to eliminate nuclear power in Taiwan, while simultaneously slashing greenhouse gas emissions by 20% from 2005 levels in line with both domestic law and international commitments. At the same time it pledges to maintain an adequate, reliable, and affordable electricity supply to power Taiwan's industrialized economy.

More than replacing the 16% of electricity currently generated by nuclear power, the government aims to see 20% power generation from renewables, based on a planned 20GW of installed solar power capacity, 4.2GW of installed onshore and offshore wind power. The Tsai administration also expects energy conservation efforts to save the equivalent of generation from two nuclear power plants, and envisions investments in renewable energy as new global business opportunities for Taiwan's industrial sector. And all of this is to be achieved in less than a decade, by 2025.

Wind and solar energy are considered to be the best self-sufficient resources available by the island. Massive investment in solar and wind power are needed for Taiwan to phase out nuclear energy and to meet its carbon abatement commitments. Especially offshore wind is regarded as the most attractive renewables to be developed since the potential capacity is estimated to be at least 6~10GW in the Taiwan Strait and it has many successful examples in Europe. The potential of offshore wind has given Taiwan a good opportunity to increase the portion of renewable energy in power supply and also to develop the local supply chain by growing it along with on-going offshore wind farm developments.

## 2 ONSHORE WIND POWER IN TAIWAN - SATURATION

Located off the eastern coast of Asia in the Western Pacific, Taiwan has profound wind energy resources. With over six months of northeastern winds every year that sweep across central and western coasts averaging 4 meters per second, or a force 3 wind on the Beaufort Scale that is strong enough to extend flags, Taiwan in fact has inherent advantages for wind power development.. Research by the Industrial Technology Research Institute (ITRI) in Taiwan shows such gentle breeze sweeps around 2,000 square kilometers of the island, most of which across the northern alpine region, western coast and archipelagos off the western coast.

However, Taiwan's onshore wind farms are saturated due to limited land space. Most of onshore wind energy resources had been constructed or planned. Taipower and InfraVest GmbH are the major developers, both of whom use imported wind turbines. Taiwan built the first onshore wind farm in offshore Penghu island early in 2001. According to the Taiwanese Bureau of Energy (BOE), by the end of 2016 Taiwan has 346 onshore wind turbines situated mainly along the western coastline and in outlying Penghu County. The total installed land-based turbine capacity is 682 MW, which accounts for 15% of all installed capacity of renewable energy. It is planned by the Bureau of Energy to build in total 450 units onshore to reach a total capacity of 1,200 MW by 2025. The new units will be able to generate 12.5 billion kilowatt hours of electricity, or 3.3 percent of Taiwan's total power generation.

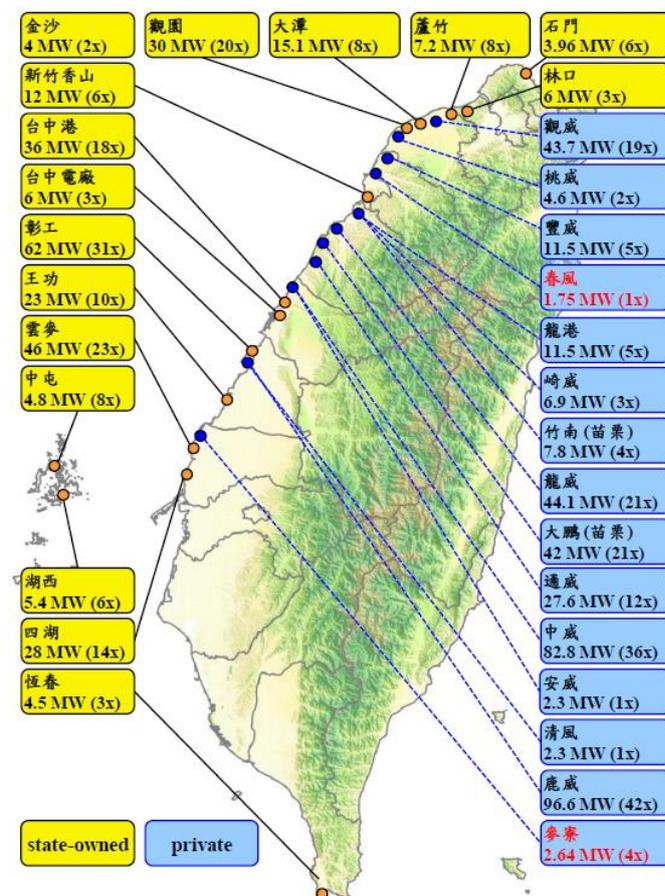
Source: Bureau of Energy, Ministry of Economic Affairs, Taiwan (Mar. 2017)

● State-owned	169 WTs/294 MW
● Private	177 WTs/388 MW
● Total installed capacity	346 WTs/682 MW (15% of all RE)
● 2015 Production	1,445 GWh (14.5% of all RE)

Info source: Thousand Wind Turbine Project website <http://www.twtpo.org.tw>

### Current 30 On-shore public and private wind farms (346 turbines) in Taiwan

(update 15/03/2017 Bureau of Energy)



It should be noticed that the average onshore wind farm in Taiwan is around 20MW due to limited land space. As a result, the first-tier 30 onshore wind farms are located sparsely along west-coast with small-scale wind farm plan.

### 3 CURRENT OFFSHORE WIND POWER DEVELOPMENT IN TAIWAN

#### 3.1 STRONG DEVELOPMENT POTENTIAL

##### 3.1.1 Abundant offshore wind resources

Taiwan possesses extraordinary advantages in developing offshore wind farms. [Offshore](#) winds blow more strongly than those [onshore](#). Taiwan is gifted with excellent wind offshore because of the Taiwan Strait's special geography which causes channeling effect. Thanks to Taiwan's unique coastal [terrain](#), to the east of the Taiwan Strait there's the Central Mountain Range, while to the west there's Fujian Province's Wuyi Mountains. The mountains act like a funnel, channeling the winds, which are very strong. Spacious sea area with strong wind enables the planning of large-scaled offshore wind farms with each installed capacity over a hundred MW, so more clean electricity can be offered for Taiwan use. Thus Taiwan has been recognized and evaluated by the international organization 4C Offshore as having the best offshore wind resource in the world.

*10-year Global Wind Speed Rankings by 4C Offshore*  
[www.4coffshore.com/windfarms/windspeeds.aspx](http://www.4coffshore.com/windfarms/windspeeds.aspx)

Rank	Name	Market	Sea	Speed (m/s)	Observations
1	Pingtan Offshore Wind Farm	China	Taiwan Strait	12.04	6 hr/day/month historic data
2	Changhua – Stage - Taipower	Taiwan	Taiwan Strait	12.02	6 hr/day/month historic data
2	Changhua – Stage III - Taipower	Taiwan	Taiwan Strait	12.02	6 hr/day/month historic data
2	Xidao - TGC	Taiwan	Taiwan Strait	12.02	6 hr/day/month historic data
2	Zhangfang – TGC	Taiwan	Taiwan Strait	11.94	6 hr/day/month historic data
6	Hibao -TGC	Taiwan	Taiwan Strait	11.94	6 hr/day/month historic data
6	Changhua – Stage IV - Taipower	Taiwan	Taiwan Strait	11.94	6 hr/day/month historic data
6	Changhua – Stage V - Taipower	Taiwan	Taiwan Strait	11.94	6 hr/day/month historic data
6	Changhua - Stage VI - Taipower	Taiwan	Taiwan Strait	11.94	6 hr/day/month historic data
6	Changhua- Stage II- Taipower	Taiwan	Taiwan Strait	11.94	6 hr/day/month historic data

##### 3.1.2 High full-load hours

Strong wind speed also contributes high “full-load hours” for Taiwan to develop offshore wind energy. Full-load hours figures refer to the number of hours per year that the wind speed at a given site is at least 10 meters per second. That is to say, winds are strong enough for the turbine to generate power at full capacity. Turbines on Taiwan’s west coast have full-load hours figure that average about 2500 hours, while at Penghu the figure rises to 3,500-4,300 hours, among the highest in the world and far better than the 2,200 hours considered reasonably good for European wind farms.

Though turbines can generate power in winds as little as 3 meter per second, but turbines in such wind condition cannot generate much power. For this reason, to estimate the quality of a wind farm the industry uses “capacity factor,” the ratio of a turbine’s actual output at a given location to the amount of power it would produce if it were to run at full load throughout the year. The average capacity factor of Taiwan’s wind turbines runs about 29%, behind only those of the UK and Japan. In Germany, by comparison, it is only 17-23%. Even in the summer when Taiwan has little wind, the figure is 20%. In Penghu the figure is much higher, at 40-50%.

### 3.1.3 High development feasibility

The conditions for building offshore wind farms in Taiwan are also excellent, approximately 1,200MW can be developed for the water depth from 5~20 meters, and more than 5,000MW can be developed for the water depth from 20~50 meters.

*Taiwan Offshore Wind Potential (Source: “Wind Resource Assessment Handbook” ITRI 2011)*

#### Shallow Water (5~20 m)

Area: 1,779.2 km<sup>2</sup>

Potential: 9 GW

Feasible: 1.2 GW

#### Deep Water (20~ 50 m)

Area: 6,547 km<sup>2</sup>

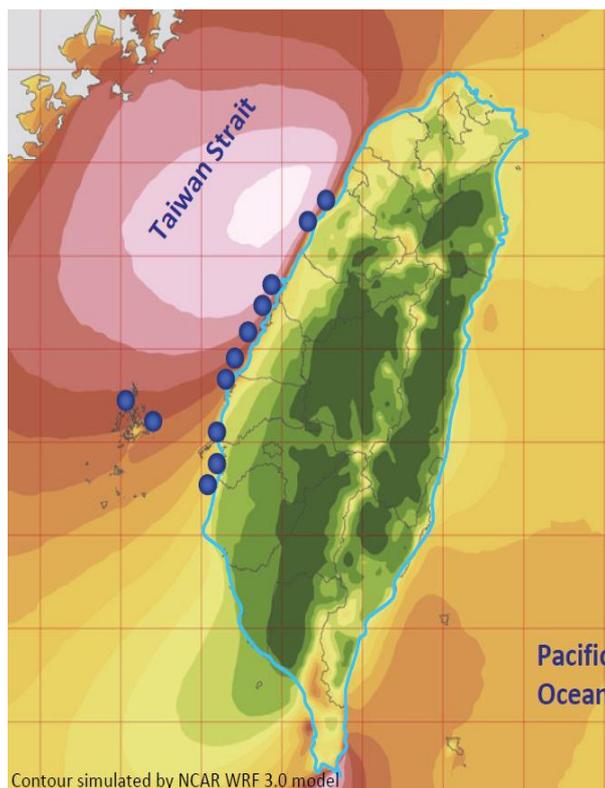
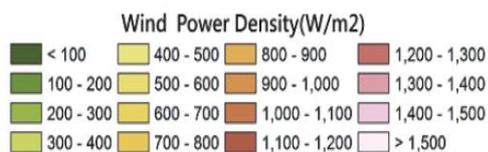
Potential: 48 GW

Feasible: 5 GW

#### Deeper Water (> 50 m)

Potential: 90 GW

Feasible: 9 GW



## 3.2 GOVERNMENT COMMITMENT

### 3.2.1 Goals set by “Thousand Wind Turbines Project”

<http://www.twtpo.org.tw>

The competent government authorities in Taiwan, the Ministry of Economic Affairs, in July, 2012 launched the “Thousand Wind Turbines Project” which set clear and ambitious targets for Taiwan’s wind energy development.

According to the “Thousand Wind Turbines Project”, Taiwan is scheduled to complete the installation of 2 offshore wind power pilot projects by 2016. After the first pilot offshore demonstration projects were completed in 2016, the government mandated to realize 520 MW offshore wind installation by 2025. Furthermore, by developing more offshore wind farms with larger scale in the deep water, the government plans to install 600 offshore wind turbines with a total capacity of 3GW by 2025.

Chart 5: Government Target for Offshore Wind Energy in Taiwan

- Short-term Target: 2 demonstration offshore wind turbines by 2016.
- Mid-term Target: Offshore 520 MW capacity by 2020.
- Long-term Target: Offshore 3,000 MW capacity by 2025.

Year	2020	2025
Onshore Capacity (MW)	745	1200
No. Installed Turbines		450
Offshore Capacity (MW)	520	3,000
No. Installed Turbines		600
Total Capacity (MW)	1,265	4,200
Total Installed Turbines		1,050

*Source: Bureau of Energy, Ministry of Economic Affairs, MOEA*

### 3.2.2 Government Purchase Guarantee - Feed-in Tariff (FiT)

Taiwan promulgated the “Renewable Energy Act” (REA) in 2009 to systematically promote renewable energy. The core of the Act provides renewable energy developers with a 20-year “Power Purchase Agreement” together with an feed-in-tariff (FiT) mechanism to kick-off the market.

Every year, the Ministry of Economic Affairs invites relevant departments, expert scholars and citizen groups to form a committee to validate and announce the wholesale buy-back price and review it on an annual basis. In principle, the tariffs shall not be lower than the average cost of domestic fossil-fueled power. The FiT for electricity generated from on-shore and offshore wind energy are set at the level of NTD2.8776/kWh (€ 8.4¢ /kWh) and NTD6.0437/kWh (€ 17.7¢/kWh) respectively. The government aims to remain at this level before large-scale deployment to enhance future development.

## ■ Feed-in Tariffs of wind power in Taiwan

- **Onshore:** NT\$2.8776 (€8.4¢) / kWh for 20 years
- **Offshore:**
  - **Option #1:** NT\$6.0437 (€17.7¢) / kWh for 20 years
  - **Option #2:** NT\$7.4034 (€21.6¢) / kWh for the first 10 years  
NT\$3.5948 (€10.5¢) / kWh for the next 10 years

Source: Bureau of Energy news release on "2017 Feed-in-Tariff for renewable energy"

### Taipower Fuel Prices as of August 2016

Energy type	costs/kWh
Coal	NT\$1.89
LNG (liquified natural gas)	NT\$2.68
Nuclear	NT\$1.11
Hydro	NT\$1.55
Solar	NT\$6.17
Wind	NT\$2.26
Average – both self-owned and purchased	NT\$1.76
Average purchased renewable	NT\$3.32

NOTE: prices reflect purchase costs

SOURCE: TAIPOWER

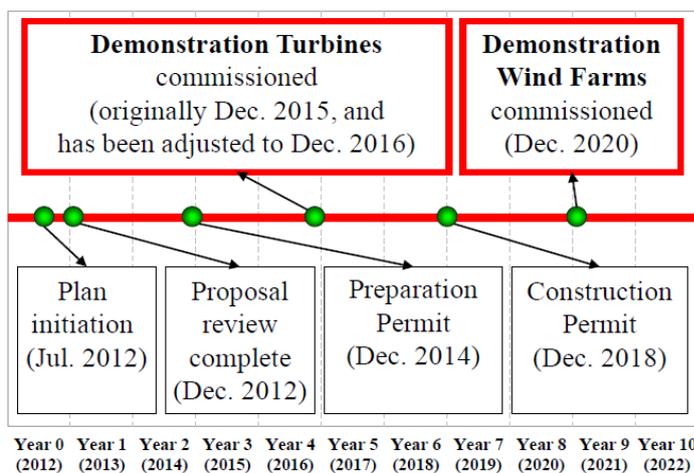
### 3.2.3 Concrete Steps: Three Phases to Develop Offshore Wind Energy

For Taiwan, the 20% level of installed wind energy capacity by 2025 is a bold plan. The government has taken concrete steps to clarify regulations and policies to give confidence to investors. Besides setting targets and put in place FIT mechanism, the government will invest NT\$1.3 trillion (US\$41 billion) to fund renewable energy development.

The government's offshore wind development is divided into three phases:

#### Phase 1: Offshore Demonstration Incentive program (2012~2020)

Goals: Two demonstration turbines to commission by 2016 and three demonstration offshore wind farms to complete by 2020.



Year 0 (2012) Year 1 (2013) Year 2 (2014) Year 3 (2015) Year 4 (2016) Year 5 (2017) Year 6 (2018) Year 7 (2019) Year 8 (2020) Year 9 (2021) Year 10 (2022)

➤ Specifications and Requirement of Demonstration Incentive Programs

- Demonstration Turbines
  - Capacity: at least 3MW each
  - Timing: Commissioned by 2016
- Met Mast
  - Water depth: 10 m or more
  - Height: 70 m or more
- Demonstration Wind Farm
  - Water depth: 5m or more
  - Capacity: 100~200 MW each
  - Timing: Commissioned by 2020

The grant was comprised of two parts: the first part was a fixed amount capped at approximately USD \$8 million for the development costs of the 100~200MW wind farm and an offshore met-mast; the second part was a subsidy on 50% of the capital expenditure of the two pilot turbines.

In 2013, the government awarded two private companies and the state-owned Taiwan Power Company to develop Taiwan's first three demonstration offshore wind farms. The two private firms are Taiwan Generations Corporation (alliance led by TGC) and Formosa Wind Power (led by Swancor).

Three Demonstration Offshore Wind Farm Pioneers in Taiwan

**1. TGC at Changhua**

Changhua Offshore Wind Farm

Capacity: 108 MW (30 turbines)

Distance from shore: 11 km

Water depth: 25-40 m

**2. Formosa Wind Power Corp. at Miaoli**

Formosa Offshore Wind Farm

Capacity: 128 MW (32 turbines)

Distance from shore: 5 km

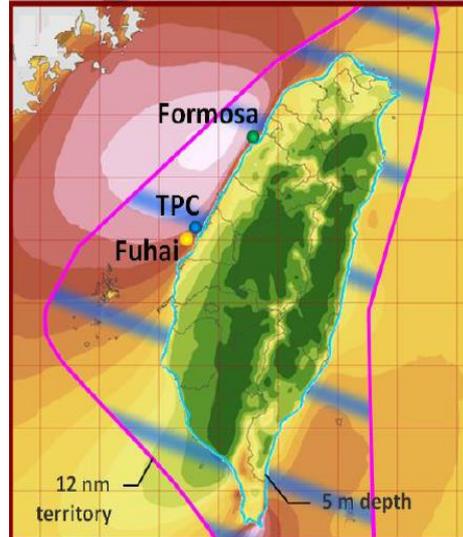
Water depth: 5-30 m

**3. Taiwan Power Co. at Changhua**

Capacity: 108~110 MW (22 turbines)

Distance from shore: 5-8 km

Water depth: 15-25 m



TGC planned the offshore wind farm 11 km off the Fang-Yuan coast in Changhua County with 30 wind turbines and a capacity of 108 MW, in water of 25-40m depth. A two-turbine Changhua Offshore Pilot Project (COPP) are to be launched first as the demonstrator. Following COPP, Fuhai Offshore Windfarm (28 turbines) along with Fuhai Phase III (20 turbines), where 5MW-above wind turbines are going to be deployed.

Swancor Renewable Energy Co. planned the Formosa OWF 128 MW offshore wind farm 5 km off the Chunan coast in Miaoli County with 32 wind turbines and a capacity of 128 MW, in water of 5-30m depth.

The demonstration incentive program is a trial model of large-scale offshore wind farm development. Originally, the first 2 pilot projects awarded to the private developers were to have begun supplying power to Taiwan's grid by the end of 2016. However, in late 2016 Swancor's vendor A2SEA using working vessel MV Torbon encountered failure in the installation of two monopiles of cylindrical steel tubes pounded into the seabed to serve as support structures for offshore wind turbines. The other private developer TGC could not even start construction work due to issues with the local fishery communities. The goal of commissioning demonstration turbines by 2016 thus has to be delayed.

The state-run Taiwan Power Company is assigned by the government to build the 3<sup>rd</sup> demonstration farm, with a capacity of 110 MW by building 22 turbines by 2020.

## Phase 2: Directions of Zone Application for Planning (2015 onward)

Goals: Applicants must acquire Environment Impact Assessment Approval by 2017 and get Preparation Permit by 2019.

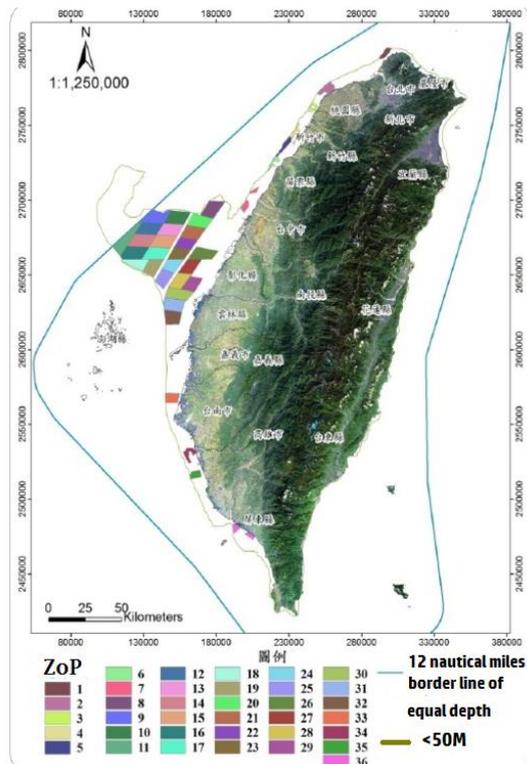
In July 2015, the Bureau of Energy promulgated the "Directions of Zone Application for Planning Offshore Windfarms" and released 36 zones of potential (ZoP) for development future commercial windfarms. The potential of total capacity is estimated at 23GW. As the possible impact on fisheries and marine ecosystems is one of the central questions concerning offshore wind development, interested developers are required to submit Environmental Impact Assessment (EIA) by the end of 2017.

The Bureau of Energy will issue EIA approval by the end of 2017 and will issue development preparation permit by the end of 2018. It is important to notice that the Taiwanese authorities will evaluate the submitted EIAs on a first-come, first-serve basis. If the same Zone of Potential has more than 2 applications, the first one who registers EIA and gets approval from Bureau of Energy will have priority to get preparation permit for developing the concerned ZoP.

The status of EIA registration is updated and open to the public on the website of Bureau of Energy website

[https://www.moeaboe.gov.tw/ecw/populace/content/ContentDesc.aspx?menu\\_id=4342](https://www.moeaboe.gov.tw/ecw/populace/content/ContentDesc.aspx?menu_id=4342) (only in Chinese)





Info source: Bureau of Energy [http://www.twtpo.org.tw/offshore\\_show.aspx?id=963](http://www.twtpo.org.tw/offshore_show.aspx?id=963)

### Phase 3: Offshore Zonal Development (2017 onward)

Offshore Zonal Development will be released in 2017. At this phase, offshore wind will be developed as a self-sustaining industry and commercial scale for cost-reduction is a major concern.

## 4 SUPPLY CHAIN AND MAJOR PLAYERS

### 4.1 LOCALIZATION

The 1<sup>st</sup> phase “Offshore Demonstration Incentive Program” aimed to facilitating the localization of offshore wind supply chain by creating domestic markets of 2 pilot farms. The needs in domestic projects are used to help build up local fleets and the abilities of marine construction, operation and maintenance. The industry is encouraged to form alliances or joint-venture with foreign corporations. For example, the four demonstration turbines constructed by the two private developers were provided from abroad. On the other hand, the other demonstration units to be built by state-run Taiwan Power Company are meant to increase domestic production ratio. In the long term, to bring down the cost per MW installed, Taiwan do need to establish complete supply chain locally.

Besides, Taiwan as an island has natural disasters such as earthquakes and typhoons which do not exist in west Europe. Those internationally available technologies do not necessarily applicable to Taiwan situation. Efforts have been put in the researching and manufacturing of key components towards the development of wind turbines and foundations with anti-earthquake, anti-typhoon and anti-corrosion characteristics.

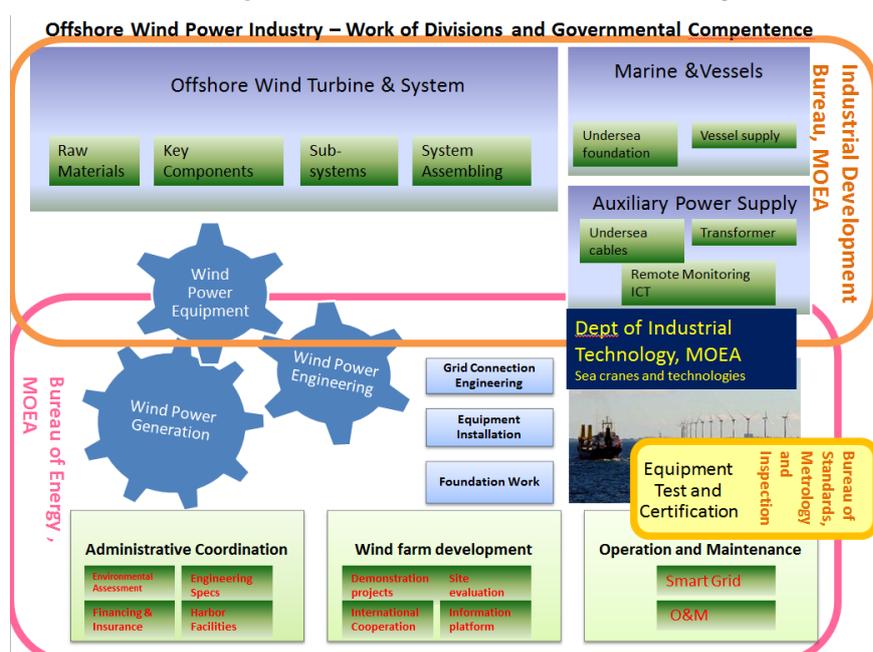


Info compiled from source: Industrial Development Bureau, Metal Industry Development and Research Center

With a sound industry base and proven capability in electrical control and mechanical manufacturing, Taiwan has many players keen to enter the emerging wind power industry. Unlike other sector focusing on export market, the domestic business opportunities of offshore wind is large enough to support the development of local wind power industry, and attract foreign investors, with joint forces from the government, policy makers, R&D institutes and various academia. A few major players are included in this section.

## 4.2 GOVERNMENT AGENCIES

Different government agencies and their respective scope of responsibilities in developing offshore wind industry in Taiwan are shown in the following chart.



**Bureau of Energy, Ministry of Economic Affairs**

<http://web3.moeaboe.gov.tw> <http://www.moeaboe.gov.tw> <http://www.twtpo.org.tw/energy@moeaboe.gov.tw>

**Industrial Development Bureau, MOEA**

[www.moeaidb.gov.tw](http://www.moeaidb.gov.tw)

IDB set out policies and guidelines for Taiwan's industrial development including energy policy and offshore wind power industry.

**Department of Industrial Technology (DoIT), MOEA**

[http://www.moea.gov.tw/Mns/doi\\_t\\_e/home/Home1\\_en.aspx](http://www.moea.gov.tw/Mns/doi_t_e/home/Home1_en.aspx)

**Bureau of Standards, Metrology and Inspections (BSMI), MOEA**

[www.bsmi.gov.tw](http://www.bsmi.gov.tw)

BSMI is the authority responsible for standardization, metrology and product inspection in Taiwan.

#### 4.3 THREE PIONEER WIND FARM DEVELOPERS

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**Taiwan Power Company**

[www.taipower.com.tw](http://www.taipower.com.tw)

No.242, Sec. 3, Roosevelt Rd., Zhongzheng District, Taipei City 10016, Taiwan

Tel: +886-2-23651234

**Taiwan Generations Corp.**

[www.taiwangenerations.com](http://www.taiwangenerations.com)

7F., No.6, Sec. 4, Xinyi Rd., Da'an Dist., Taipei City 106, Taiwan (R.O.C.)

Tel. + 886-2-2705 2555 Fax.+ 886-2-2704 2555

**Formosa Wind Power Company (Swancor)**

[www.swancor.com.tw](http://www.swancor.com.tw) Taipei office Tel: 02-27751387

9F-1, No. 127, Fu-Xing North Rd., Taipei

#### 4.4 MAJOR R&D INSTITUTES, INDUSTRIAL ASSOCIATIONS AND COMPANIES

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**The Green Energy and Environment Research Laboratories, ITRI**

<http://www.itri.org.tw> 工業技術研究院 綠能與環境研究所 (風力資訊整合平台)

<http://wind.itri.org.tw>

<https://www.itri.org.tw/eng/econtent/research/research05.aspx>

General contact phone: 886-3-591-2251

Address: 195, Sec. 4, Chung Hsing Rd., Chutung, Hsinchu, Taiwan 31040

**Taiwan Wind Energy Association 台灣風能協會**

<http://www.twnwea.org.tw/>

24 Bldg, No.195, Sec. 4 Chung Hsing Rd., Chu Tung, Hsin Chu 31040, Taiwan

Tel +886-3-5914213 E-mail : [TwnWEA@twnwea.org.tw](mailto:TwnWEA@twnwea.org.tw)

Detail list of member companies <http://www.twnwea.org.tw/Association.aspx>

**Taiwan Wind Turbine Industry Association (TWTIA)**

<http://www.twtia.org.tw>

C/O: **Metal Industries Research Development Center**

<http://www.mirdc.org.tw/English/index.aspx>

Tel +886-7-351-3121

**China Steel Corp.**

[www.csc.com.tw](http://www.csc.com.tw)

Add: No. 88, Cheng-Gong Road, Kaohsiung, Taiwan

Attn: Offshore Wind Commission

[Tel +886-7-3371111](tel:+886-7-3371111)

**Teco Electric and Machinery Co. Ltd.**

[www.teco.com.tw](http://www.teco.com.tw)

Add: 5F, No. 19-9, San Chong Road, Nangung District, Taipei 11560, Taiwan

General phone +886-2-2655 3333

Teco develops Taiwan's first domestically-made 2MW permanent-magnet synchronous wind turbine motor.

**Siemens Limited Taiwan**

[www.siemens.com.tw](http://www.siemens.com.tw)

Add: 8F, No. 3, Park Street, Nangang District, Taipei 11503, Taiwan

General phone +886-2-2652 8888

## 5 OPPORTUNITIES FOR FLEMISH COMPANIES

Taiwan has abundant wind resources and feasible seabed. Dedicated government and competent authorities have allocated subsidy, set clear targets, concrete development phases and 20-year power buy-back (FiT) mechanism. Localization of supply chain infrastructure is aimed to sustain long-term development and to bring down cost of per installed MW.

On the other hand, Taiwan's goals for transforming the energy sector have many challenges. Offshore wind-power development, for example, must take into account the frequent earthquakes and typhoons occurred in this area. Different interest groups also question on the impacts on the marine ecosystem and fishery industry. Special know-how, fleets, harbors, project management and project financing for the offshore wind farm construction, operation and maintenance are yet absent. Taiwanese wind turbine builders, especially off shore project are short of precise pre-construction risk assessment and hence are exposed to potentially huge losses during work. Lack of coordination among relevant government agencies, and an complicated approval process for renewable energy projects are frequently heard critics. The regulatory regime still has to be developed.

To bridge these gaps, Taiwan has been inviting experienced offshore-wind developers, primarily from Europe, to participate in building the market. The market is fairly transparent and open for foreign players. Response from the global renewable energy industry has been highly favorable. Siemens in early 2017 announced to move the groups offshore wind team from Shanghai to Taipei. Many companies have come set up companies in Taiwan to grasp the business opportunities, to name a few DONG Energy and EOLFI. Taiwan can actually shorten the learning curve and benefit from the European experiences.

The Belgian authorities have appointed areas for offshore wind farms early in 2004. Belgium prides to have the deepest and furthest offshore wind farms into operation in year 2013, with 603 MW energy needs for 460,000 families, and the largest wind turbine (6MW). By the end of 2017, there will be in total three commercial off-shore wind farms in operation. Besides, with long experience in off-shore gas and oil projects, Belgium has the expertise in marine engineering, sub-sea engineering, onshore infrastructure, project finance & insurance, environmental impact assessment solutions, wind farm port logistics and facilities, etc. Belgian

companies in this sector are highly recommended to pursue the business opportunities in the Taiwanese offshore-wind energy market, before it's too late when all EIA approvals for the 36 planned Zone of Potential are issued by the end of 2017 and permits issued by the end of 2018.

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