# Assessment of Floating Offshore Wind Farm in Korea

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***Abstract:*** *Wind farm is the preferred renewable energy option in the Korean peninsula as the mountainous geography covered by three water bodies provides ample wind power. As such, wind farm is considered as a promising technology that supports the Korean green growth endeavors. This paper assesses and verifies the economic feasibility of the cutting-edge technology for the newly emerging float-type offshore wind turbine which has a competitive advantage against conventional land-based and fixed-type offshore wind turbines. The paper will comprehensively evaluate offshore floating wind turbine capacity and its economic feasibility for use in large scale wind farms.*

***Keywords:*** *Floating wind turbine, Vertical-type, Horizontal-type, Korea*

# Introduction

Wind energy, a zero-carbon electricity generation source, is an essential element in meeting Korea's ambitious greenhouse gas reduction goals along with securing energy resources. Surrounded by three bodies of water, Korean offshore wind capacity is deemed stronger than that onshore. Thus this research aims to provide valuable information as to facilitate market penetration of Korean offshore floating wind industries

# Approach

### LCOE (Levelized Cost of Energy)

$$LCOE = \frac{\sum_t^n \frac{I_t + M_t}{(I_0 + r)^t}}{\sum_t^n \frac{E_t}{(I_0 + r)^t}} \qquad \text{Eq. (1)}$$

Where $I_t$ denotes investments at time t; $M_t$ denotes operation and maintenance costs at time t; $E_t$ denotes energy generation at time t; r denotes the evaluation discount rate; t denotes the time, ranging from zero to n.

### NPV (Net Present Value), IRR(Internal Rate of Return)

$$NPV = \sum_t^n \frac{R_t}{(1 + r)^t} \qquad \text{Eq. (2)}$$

Where Rt denotes net cash flow at time t; r denotes the evaluation discount rate; t denotes the time, ranging from zero to n.

# Concept

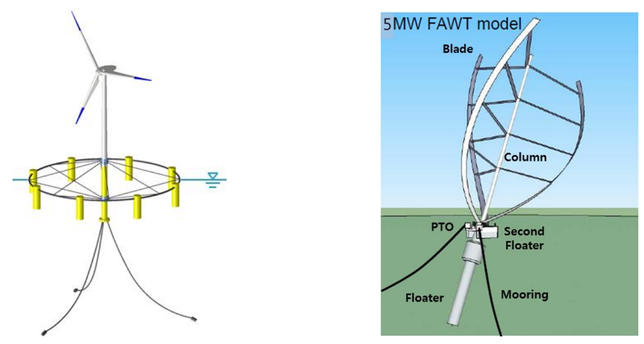


Fig. 1: KAIST's Concept (Horizontal Type, Vertical type)

| Category | Horizontal Type | Vertical Type |
|---|---|---|
| Capacity(MW) | 5 | 5 |
| Rated wind speed(m/s) | 11.4 | 15 |
| Rotor diameter(m) | 126 | 91.1 |
| Rotor height(m) | 90 | 136.7 |
| Total weight(ton) | 1090 | 1284.92 |
| Blades & Support(ton) | 110 | 249 |
| Generator(ton) | 240 | 141 |
| Central column(ton) | 347 | 336.5 |
| Floater(ton) | 360 | 472.42 |

Table. 1: Technical specification of Wind Turbine

# Underlying Condition

| Category | Value |
|---|---|
| Years of development | 2013-2018 |
| Years of commissioning | 2018 |
| Years of operation | 20 |
| Number of turbines | 1 |
| Installed capacity | 5MW |
| Water depth | 60m |
| Distance to port and grid connection | 1km |
| Average wind speed | 6.56m/s |

Table 2: Project information for the wind turbine

# Life Cycle Cost Analysis

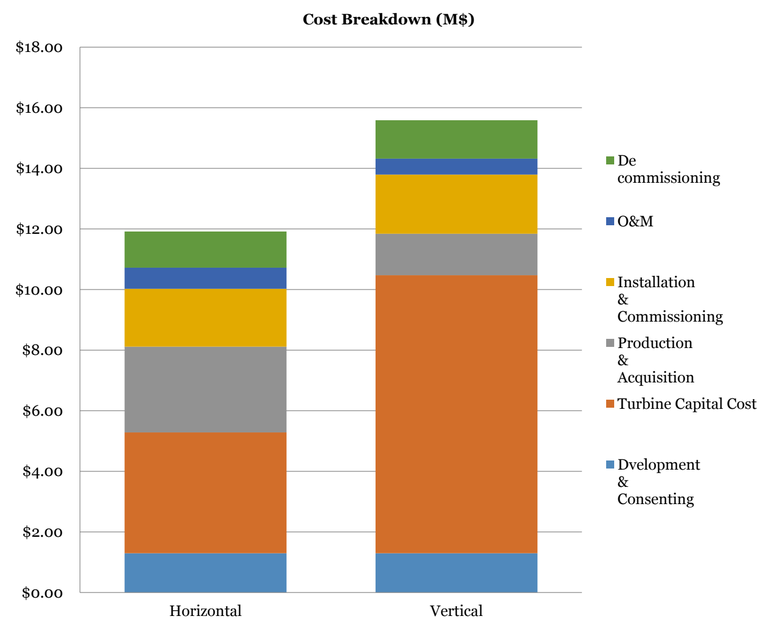


Fig.2 : Cost Breakdown wind turbine

# Result

| Category | Horizontal Type | Vertical Type |
|---|---|---|
| Rating (MW) | 5 | 5 |
| Capacity (%) | 28.2 | 25.8 |
| Total Weight (ton) | 1090 | 1284.92 |
| Floater (ton) | 360 | 472.42 |
| Interest Rate (%) | 5~15 | 5~15 |
| Investment Cost (M$) | 11.2 | 15.1 |
| Period (Year) | 20 | 20 |
| Depreciation (M$) | 0.56 | 0.75 |
| O & M (M$) | 0.7 | 0.52 |
| Tax (Year) | 0.21 | 0.16 |
| Power Volume (MWh) | 12,351 | 11,300 |
| Base Price ($/KWh) | 0.08 | 0.08 |
| SMP ($/KWh) | 0.2 | 0.2 |
| Sales Revenue (1yr) | 2.09 | 1.91 |
| IRR (%) | 11.1 | 5.2 |
| NPV (M$) | 6.17 | 0.86 |
| LCOE ($/MWh) | 150 | 195 |
| Payback Period (Year) | 7.90 | 12.28 |

Table. 3: Economic analysis of Wind Turbine

## Reference

[1] Anders Myhr, Catho Bjerkseter, Anders Ågotnes, Tor A. Nygaard, "Levelised cost of energy for offshore floating wind turbines in a life cycle perspective", Renewable Energy 66 (2014) 714-728
[2] Hiromichi Akimoto, Kenji Tanaka and Kiyoshi Uzawa, "Floating axis wind turbines for offshore power generation—a conceptual study", 4 November 2011
[3] G.R. Fulton, D.J. Malcolm, H. Elwany, W. Stewart, E. Moroz, and H. Dempster , "Semi-Submersible Platform and Anchor Foundation Systems for Wind Turbine Support",,August 30, 2004 – May 31, 2005,