Proposal for Offshore Wind Farm with Triangle-Coupled Movable Parallelogram Buoyancy Structure for the High Seas

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Abstract: We are responsible for providing energy and food resources for our next generation. After more than 20 years of research, the author has confirmed that the VAWT with flip-up mechanism can maintain rotation without the brake, even in strong winds. Experiments have shown that the triangularly coupled movable parallelogram buoyancy structure makes it easy to maintain the verticality of the wind turbine tower even under large waves. Furthermore, as a result of studying the connection between the HAWT (horizontal axis wind turbine) and the movable parallelogram buoyancy structure of the triangular connection, the feasibility was confirmed. The only way for all people in the world to secure energy and food fairly is to look for the remaining areas such as the high seas. The author would like to propose the use of the high seas to combat global hunger, which is likely to be a global problem in the future.

Key words: Energy and food resources for our grandchildren and following generations, deeper than 200 m, offshore, triangle-coupled movable parallelogram buoyancy structure, VAWT with flip-up mechanism, HAWT, high seas.

1. Initial Thoughts

1.1 Current Situation

The offshore wind power generation system has been under discussion for a long time, but the fact is that practical application in the sea areas deeper than 200 m has hardly progressed.

At present, only the landing type offshore wind power generation system is operating in the sea area shallower than 200 m.

We are responsible for providing energy and food resources for our grandchildren and following generations.

It is the responsibility of engineers involved in wind power generation to put floating offshore wind power generation to practical use in sea areas of 200 m or more.

1.2 General Considerations

With regard to offshore wind power generation in sea area deeper than 200 m, the following items are considered essential matters.

The water depth should be targeted at 200 m to 10,000 m.

Since the installation location is far from land, it is essential that the solution is maintenance free.

Consistency between the horizontal axis wind turbine and the buoyancy structure must be ensured.

Since offshore wind power generation systems occupy a vast area of water, it is absolutely necessary to produce not only power generation but also food production such as aquaculture.

Produced electricity and food should be properly treated and transported.

2. Specific Considerations

2.1 The Water Depth Should Be Targeted at 200 m to 10,000 m

For example, when the water depth is about 500 m, it is necessary to use three or more anchors for one windmill, and the chain must have a length of 500 m or more.
As a result, the chain weight becomes very heavy, and the buoyancy structure also has to be large in order to produce the necessary buoyancy.

Furthermore, in order to provide the perpendicularity of the buoyancy structure efficiently, it is necessary to enlarge the restoring ability of the buoyancy structure.

To solve these problems, anchors should not be connected to individual buoyancy structures. A plurality (at least 10 or more) of buoyancy structures should be connected to the anchors.

In the beginning of designing the floating offshore wind power generation system, the author studied various methods in order to solve several major problems such as those mentioned above.

As a result, he came up with (a triangular coupled buoyancy structure with flexible link mechanisms).

Based on the concepts stated earlier, the author made various types of prototypes. After many experiments in rivers and lakes near his home, he became convinced of the feasibility of this offshore wind power system.

2.2 Since the Installation Location Is Far from the Land, a Maintenance-Free Solution Is Essential

The fact that the installation site is far from the land means that it is difficult to be near the site when something goes wrong. In addition, strong waves are usually present, leading to conditions that are difficult to work in.

In other words, troubleshooting is very difficult. For this reason, windmills and other equipment used on site should be maintenance-free for at least 10 years.

In order to satisfy the above conditions, frictional damage must be minimized.

In other words, gearboxes that use gears, brakes that use friction, etc. should be excluded.

While designing a wind turbine, to eliminate the frictional damage, the author had conceived the idea of VAWT (vertical axis wind turbines) with flip-up mechanism.

Based on the concept stated earlier, the author made various types of prototypes over the course of 20 years.

After many experiments in rivers and lakes near his home, the feasibility of VAWTs with flip-up mechanism was confirmed. As for the gearless gearbox, a non-contact type gearbox (speed increase ratio is about 5 times) was prototyped based on a new concept, and the necessary transmission torque was secured. The operation seemed promising.

If this speed increaser is connected in two stages, a non-contact speed increase of about 25 times will be possible.

The author verified the prototype of the retractable front edge slat and obtained the result that the torque shortage of the VAWT in the low wind speed range can be improved.

A 36-pole multi-pole coaxial generator was also prototyped with promising results.

2.3 Consistency between the Horizontal Axis Wind Turbine and the Buoyancy Structure Must Be Ensured

In order to accelerate the practical application of floating offshore wind power generation systems, it is essential to develop triangular coupled buoyancy structures and large VAWTs.

However, it is very difficult to procure a large VAWT in a short period of time.

Large VAWTs do not currently exist anywhere in the world.

Early offshore wind systems can be put to practical use if docking between horizontal axis wind turbines and triangular coupled buoyancy structures is possible.

The author has considered this possibility as the main theme for about five years.

As a result, the author has learned that the verticality of a horizontal axis wind turbine can be successful by combining the counterweight mechanism of a horizontal axis wind turbine with a triangular coupled buoyancy structure.

Based on the results, the author would like to propose triangular coupling buoyancy structure and horizontal axis wind turbine coupling system.
2.4 Since Offshore Wind Power Generation Systems Occupy a Vast Area of Water, It Is Absolutely Necessary to Produce not only Power Generation but also Food Such As Aquaculture

It is possible to place aquaculture cages between and around the triangular connections of a trianally coupled buoyancy structure.

This makes it possible to achieve the goal of food production.

Aquaculture includes not only fish, but also shellfish and seaweed.

Feeding of the fish and shellfish should be automated.

The seawater temperature, dissolved oxygen concentration, and salinity of the aquaculture environment must be calculated and controlled to a predetermined level automatically.

2.5 Produced Electricity and Food Should Be Properly Treated and Transported Properly

Offshore wind farms that are installed away from the land may have hundreds of wind turbines. Therefore, the treatment and transportation of electricity generated by them will be an important factor to consider.

In addition to transmission by cable, electricity processing and transportation are important themes in the deep-sea area, such as storage and generation of hydrogen and their transportation.

In order to maintain the freshness of fish, shellfish, and seaweeds, the processing, canning, freezing and transportation of foods are indispensable.

3. Solutions for Specific Consideration

3.1 Triangular Coupled Buoyancy Structure with a Flexible Link Mechanism

The basic idea of this method is based on a combination of the following two items.

For Item 1, two windmill floating towers are formed into parallelograms by two horizontal struts. By making each connecting portion of the parallelogram movable, the two windmill floating towers can move in parallel with each other.

For Item 2, the three windmill floating towers are firmly and evenly stabilized by combining the movable parallelograms to form a flat triangle.

With the combination of the above two items, the three wind turbine floating towers can move in parallel with each other.

In other words, the windmill floating towers can help each other to maintain their own verticality.

Three vertical floating structures which are combined as a triangle on a plane surface form the basic combination (Fig. 1). When multiple floating structures are combined, the triangular floating structure is the basic form. These structures have a very wide and open area. The aquaculture cage can be installed in a triangular floating structure (Fig. 2).

3.2 VAWT with Flip-up Mechanism

The concept of the VAWT with flip-up mechanism is as follows.

The vertical wing balances at a predetermined angle by the resultant force of the wing's own weight, centrifugal force due to rotation, and wind power caused by the wind (Fig. 3).
The balance angle is generally determined by the centrifugal force accompanying the windmill rotation at that time.

For this reason, even if the rotational speed increases due to a huge typhoon, the angle at which the vertical wing is raised increases, and the generated rotational torque decreases (Fig. 4).

As a result, the rotation speed does not exceed the preset value without using a brake, and damage due to centrifugal force can be prevented.

Furthermore, through the verification process it was confirmed that even if an abnormal force is generated due to turbulence such as a typhoon, it has an effect of averaging against a local force, while rotating at a high speed.

VAWTs have several advantages compared to horizontal turbines.

Advantages include: (1) no unbalanced load around the rotating shaft, (2) no necessity of yawing to face the wind, (3) simpler mechanism which leads to a fewer problems, lower initial costs and lower maintenance costs.

Fig. 3 shows how a VAWT with a flip-up mechanism balances its own weight, centrifugal force and wind power.

The angle of the vertical wings will vary with centrifugal force and wind forces as shown in Fig. 4.

Thus, the self-stable vertical axis wing will continue to rotate without a control system, no matter how strong the wind blows, and will not stop rotating even under hurricane or tsunami conditions [1, 2].

3.3 Modification of HAWT

Large numbers of HAWTs have been installed in implantable offshore wind farms throughout the world.

Solutions to the Horizontal–axis wind turbine problems of unbalanced load around the rotating shaft and the necessity of yawing to face the direction of the wind exist (Fig. 5).

These solutions utilize attached counter weights as shown in Fig. 6.

3.4 It Is Necessary to Produce food Such As Fish Farming in Addition to Power Generation

Fishermen and wind power generation operators can plan and operate jointly.
Collaboration between fisherman and wind power generation operators is very important and essential.

4. Prototyping and Evaluation

In order to prove the feasibility, the author made hand-made prototypes and evaluated and verified them.

4.1 Triangular Coupling of the Floating Structure with Flexible Rectangular Link Mechanism

4.1.1a VAWT with the Sub-float

Photo 1 shows a float, vertical tower, and the bottom weight on the floating pier.

Sub-float mounting radius is 100 cm (Photo 2).

Restoring force of the sub-float is large.

4.1.1b Floating Structure with Sub-float

The diameter of the sub-float is 2 m. The diameter of the vertical wing is 1.5 m. The depth of the weight is 2.5 m (Photo 3).

4.1.1c Test of the Restoring Characteristic of the Floating Structure with Sub-float

The restoring characteristic of the floating structure with sub-float was performed with the following test system.

Photo 4 shows restoring characteristic test on the lake.
4.1.2a First Prototype of Triangular Coupling of the Floating Structure with Flexible Rectangular Link Mechanism

There are two types of models. One is for measuring the sinking of the float while the other one is for measuring the inclination of the tower. The author tested the maintainability of the vertical axis by changing the weight at the bottom of the vertical axis. The evaluations were conducted on a river.

This test covered the relationship between the vertical axis and the position of support with the anchor. The flow of the river is very similar to an ocean current. Photo 5 shows the detecting unit.

Photo 6 shows Triangular Floating Structure with the detecting unit.

4.1.2b Result

The following data show that the heavier the weight, the smaller the angle of inclination. For example, the heaviest weight, weight 3, gave the attenuation effect of 15%. In this case, the angle of inclination is 1.7° for the sinking angle of 11.2°.

Attenuation effect of flexible link mechanism
- Sinking angle versus attenuation angle
- Attenuation effect for weight-1 = 44%
- Attenuation effect for weight-2 = 38%
- Attenuation effect for weight-3 = 15%

Graph 1 shows the attenuation effect of the flexible link mechanism.

Graph 1  Attenuation effect of flexible link mechanism.

From the above results, if you want to further increase the damping effect, you can make the weight heavier, but in that case, it is necessary to increase the buoyancy of the float accordingly.

4.1.3a Second Prototype of Triangular Coupling of the Floating Structure with Flexible Rectangular Link Mechanism

The purpose of the second prototype is to carry out various evaluations by mounting a VAWT with a diameter of about 1 m, as shown below.

The length of one side of the triangle is 2 m. The depth of the weight is 1.5 m. The height of the wind turbine tower is 1.5 m (Photo 7).

Each wind turbine tower is able to move up and down staying parallel to each other (Photo 7).

4.1.3b Evaluation Method

In Evaluation 1, the flexible rectangular link mechanism was locked to prevent free parallel
movement of the towers of each wind turbine, and one triangular tower was moved up and down with a stick to evaluate the angle change of the towers.

In Evaluation 2, the flexible triangular link mechanism was activated, and one triangular tower was moved up and down with a stick to evaluate the angle change of the tower.

4.1.3c Result
The triangular coupling of the floating structures was evaluated in the river (Photo 8).

In Evaluation 1, the horizontal bar angle change and the tower angle change were the same.

In Evaluation 2, there was almost no change in the angle of the tower with respect to the change in the angle of the horizontal bar.

4.1.4 Triangular Coupling of the Floating Structure with VAWT with Flip-up Mechanism
The diameter of the vertical wing is 1 m. The height of the vertical wing is 1 m.

Photo 9 shows the Triangle Floating Structure with VAWTs on the lake.

In winds of 15 m/s, it was possible to confirm the verticality of the wind turbine shaft and stable rotation.

4.2 VAWT with Flip-up Mechanism

4.2.1 First Prototype of VAWT with Flip-up Mechanism
The flip-up mechanism will never activate below a preset rotation rate in order to maximize the energy produced (Photo 10). Then, above a preset rotation rate, the flip-up mechanism will activate to prevent destruction of the wing under hurricane force winds (Photo 11). The diameter of the vertical wing is 1 m. The height of the wing is 1 m [1, 2].

Various Modes of Flip-Up State
Graph 2 shows three modes of flip-up state.

Graph 2a shows the normal state without flip-up under wind speed of 20 m/s or less.

Graph 2b shows the flip-up state under wind speed of 50 m/s.

Graph 2c shows the super flip-up state over 50 m/s.
4.2.2 Second Prototype of VAWT with Flip-up Mechanism

The flip-up mechanism will never activate below a preset rotation rate in order to maximize energy produced (shown in Photo 12). Then, above a preset rotation rate, flip-up mechanism will activate to prevent destruction of the wing under hurricane force winds (shown in Photo 13). The diameter of the vertical wing is 1.5 m. The height of wing is 1.5 m [1, 2].

4.2.3 Leading Edge Slat

In order to improve the performance of low wind speed area, leading edge slat will be used (Photo 14).

4.2.4 Movable Leading-Edge Slat

In order to improve the starting characteristics in low wind speed conditions, a leading-edge slat is used. The leading-edge slat is open below the predetermined wind speed (Photos 15 and 16).
4.2.5a Direct Drive Generator without Acceleration Gears

The main purpose of direct drive generator is to supply the maintenance-free system without a gear acceleration mechanism. This includes 36 pairs of magnets and coils. The 36 coils do not rotate to prevent...
the need for a slip ring which would be damaged by friction. Thirty-six (36) pairs of magnets will rotate (Photo 17).

Photo 18 shows the testing of the VAWT design. This gave the following data: wind velocity, rotation speed of wing, ac signal from generator, output of oscilloscope, behavior of rotation.

4.2.5b Testing of Direct Drive Generator for VAWT (under Testing of VAWT)

Photo 18 shows AC signal from generator.

The direct drive generator will give us a maintenance-free wind turbine. This system will give us low-cost generation of electricity. This generator will be placed near large diameter bearing and will be very easy to maintain assembly of magnet & coil from a lower part.

4.2.6 Non-contact-type Speed Increaser Trial Manufacture

Non-contact type speed increaser with a speed-up ratio of about 5 was hand-made and prototyped, and transmission torque and transmission speed were verified for prescribed performance. Photo 19 was connected to a 100 W class multi-pole synchronous generator, and was able to achieve a predetermined amount of power generation. As the next step, it is expected that an increase ratio of about 25 can be achieved by combining the present system in a double connection (Photo 19).

4.3 Computational Evaluation of Triangularly Coupled Floating Structures with HAWT

4.3.1 Verification of Horizontal Axis Wind Turbine

When a horizontal axis wind turbine or a VAWT with the same weight $w_1$ was placed on the buoyancy structure, the counter weight $W$ required for the buoyancy structure to balance the weight was calculated (Fig. 8).

Counterweight position and wind turbine tower axis are as follow (Fig. 8).

4.3.2 Calculation Formula

\[
W = \frac{L_1 + L_2}{L_2} w_1 \quad (1)
\]

HAWT Method-1

\[
W = \frac{A + L_2}{L_2} \left( L_1 + L_2 \right) w_1 \quad (2)
\]

HAWT Method-2

\[
W = \left[ 1 + \frac{A}{L_2 \sin \theta + B \cos \theta} \right] w_1 \quad (3)
\]

HAWT Method-3

\[
W = \frac{L_2}{L_2} \left( L_1 + L_2 \right) + \frac{A}{\tan \theta} w_1 \quad (4)
\]

4.3.3 Calculation Result

Table 1 shows the calculation of $W$ using the assumed values of $W_1 = 1,000$ kg, $L_1 = 30$ m, $L_2 = 45$ m, $A = 3$ m, $B = 6$ m.
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![Diagram of wind turbines and floats](image)

**Fig. 8** Perspective view of various wind turbines and floats and weights.

Parameter description: $W_1 \rightarrow$ Wind turbine weight, $W_2 \rightarrow$ Wind turbine counter weight, $W_3 \rightarrow$ Counter weight in case of method 2, $L_1 \rightarrow$ Distance from water surface to wind turbine, $L_2 \rightarrow$ Distance from water surface to counter weight, $A \rightarrow$ Distance between wind turbine position and wind turbine tower axis, $B \rightarrow$ Distance between counterweight position and wind turbine tower axis.

**Table 1** Comparison of vertical axis wind turbine and various horizontal axis wind turbines.

| Reference | Vertical axis | Horiztonal axis Method-1 | Horiztonal axis Method-2 | Horiztonal axis Method-3 |
|-----------|--------------|---------------------------|---------------------------|---------------------------|
| Initial value | $W_1$ (ton) | $L_1$ (m) | $L_2$ (m) | $A$ (m) | $B$ (m) |
| $\theta = 1^\circ$ | 1.67 | 2.50 | 1.52 | 3.67 | 5.49 |
| $\theta = 2^\circ$ | 1.67 | 2.50 | 1.53 | 3.58 | 5.38 |
| $\theta = 3^\circ$ | 1.67 | 2.50 | 1.55 | 3.49 | 5.30 |
| $\theta = 4^\circ$ | 1.67 | 2.50 | 1.56 | 3.40 | 5.23 |
| $\theta = 5^\circ$ | 1.67 | 2.50 | 1.57 | 3.38 | 5.20 |
| $\theta = 6^\circ$ | 1.67 | 2.50 | 1.58 | 3.35 | 5.15 |
| $\theta = 7^\circ$ | 1.67 | 2.50 | 1.59 | 3.31 | 5.11 |
| $\theta = 8^\circ$ | 1.67 | 2.50 | 1.60 | 3.28 | 5.06 |
| $\theta = 9^\circ$ | 1.67 | 2.50 | 1.61 | 3.25 | 5.02 |
| $\theta = 10^\circ$ | 1.67 | 2.50 | 1.62 | 3.22 | 4.98 |
| $\theta = 11^\circ$ | 1.67 | 2.50 | 1.63 | 3.19 | 4.94 |
| $\theta = 12^\circ$ | 1.67 | 2.50 | 1.64 | 3.16 | 4.90 |
| $\theta = 13^\circ$ | 1.67 | 2.50 | 1.65 | 3.13 | 4.86 |
| $\theta = 14^\circ$ | 1.67 | 2.50 | 1.66 | 3.10 | 4.82 |
| $\theta = 15^\circ$ | 1.67 | 2.50 | 1.67 | 3.08 | 4.78 |
| $\theta = 16^\circ$ | 1.67 | 2.50 | 1.68 | 3.05 | 4.74 |
| $\theta = 17^\circ$ | 1.67 | 2.50 | 1.69 | 3.03 | 4.70 |
| $\theta = 18^\circ$ | 1.67 | 2.50 | 1.70 | 3.00 | 4.66 |
| $\theta = 19^\circ$ | 1.67 | 2.50 | 1.71 | 2.99 | 4.62 |
| $\theta = 20^\circ$ | 1.67 | 2.50 | 1.72 | 2.97 | 4.58 |
4.3.4 Relationship between Weight and Tower Angle

Graph 4 is created from Table 1.

4.3.5 Result of Calculation

When the angle is 1 degree, $W$ is as follows.

1. is VAWT and $W = 1.67$ ton
2. is HAWT NO1 and $W = 2.5$ ton
3. is HAWT NO2 and $W = 1.52$ ton
4. is HAWT NO3 and $W = 5.49$ ton

HAWT NO2 has the smallest $W$ in HAWT. Moreover, it is a little smaller than VAWT.

The relationship between the weight of the tower and the tilt angle of the tower is shown in Graph 4.

Graph 4  The relationship between the weight of the tower and the tilt angle of the tower for various type of wind turbines.

Fig. 9  VAWT and various HAWTs with floats and weights.

4.3.6 Best of HAWT

Therefore, the HAWT whose performance is comparable to the VAWT is 3 HAWT NO2 $W = 1.52$ tons.

So, 3 HAWT NO2 is best of the HAWT designs.

5. is used to maintain the verticality of the wind turbine tower shaft of 3 continuously, and is used to reduce the adverse effects of strong winds and tsunamis.

4. HAWT NO3 is the most worst case which has no treatment for maintaining the verticality of the wind turbine tower shaft.

4.3.7 Triangular Coupled Floating Structure with HAWT NO2

Solutions to the horizontal-axis wind turbine problems of unbalanced load around the rotating shaft and the necessity of yawing to face the direction of the wind exist. These solutions use an added variable torque capable counterweight, as shown in Fig. 11.
4.4 Conclusion of Prototyping and Evaluation

Triangular connections in a floating structure with a flexible parallelogram link mechanism have proven to work well with several prototypes and evaluations.

4.5 Fishery and Collaboration

Fishermen have been using vast areas of the sea for a very long time. Wind power should not interfere with fishing operations.

By installing the fish cages between the wind turbines, wind power generation and the farming of fish could be concurrently performed.

Fishermen are familiar with the operation of devices such as marine engines and fish finders.

Routine maintenance of devices such as wind power related equipment should be able to be carried out without problems.

Fishermen can obtain a maintenance fee in exchange for continued maintenance.

Small and medium-sized offshore wind power producers are very important from the viewpoint of the local production for local consumption.

Fishermen and wind power generation operators can plan and operate jointly.

Collaboration between fisherman and wind power generation is very important and essential.

5. Proposal-1

5.1 Contents of Proposal-1

- Proposal of a common station for evaluation
- Proposal to apply various wind turbines
- Proposal of Anchor system for common station
- Proposal of collaboration between fisheries and wind power generation
- Proposal to apply HAWT for common station

5.2 Proposal of a Common Station for Evaluation

5.2.1 Triangle Bond Wind Turbine for the Common Station

Fig. 1 shows a common station for wind turbine evaluation with three wind turbine floating towers.
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This includes movable parallelograms in the vertical direction, triangles in the horizontal direction.

Fig. 2 shows example with aquaculture cages.

5.2.2 Common Station for Multi-coupled Wind Turbine

Fig. 12 shows five wind turbines. Fig. 13 shows seven wind turbines. Fig. 14 shows for 11 wind turbines.

5.3 Proposal to Apply Various Wind Turbines

5.3.1 Common Coupling Unit for Wind Turbines

Fig. 15a shows a basic float of the common station for the evaluation of wind turbines.

Fig. 15b shows a straight Darrieus wind turbine with flip-up mechanism.

Fig. 15c shows a straight Darrieus wind turbine.

Fig. 15d shows a Horizontal axis wind turbine.

Common station for wind turbines is coupled with the various wind turbines using a common coupling unit.

The common coupling unit is installed on top of the basic float.

5.3.2 Binding of VAWT and the Common Station for Evaluation

Fig. 16 shows the docking of VAWT with flip-up mechanism and basic float. Fig. 17 shows that three VAWTs are installed on a common station. Aquaculture ponds have also been installed. We are farming at sea and deep range by the vertical movement mechanism.

5.4 Proposal of Anchor System for Common Station

5.4.1 Anchor System for Three Wind Turbines

- Fig. 18 installed three wind turbine groups with three anchors for position holding.
- Example with aquaculture cages installed.
5.4.2 Anchor System for Eleven Wind Turbines
Fig. 19 shows 11 wind turbines installed with six anchors for positioning.
There are 5 fish preserves each in the sea surface area and deep-sea area.
The automatic feeding system is also installed.
If one wind turbine produces 10 MW, the total power generation is 110 MW.

5.4.3 Anchor System for 22 Wind Turbines
Fig. 20 shows 22 wind turbines installed.
Total power generation amount = 220 MW.

5.4.4 Anchor System for 44 Wind Turbines
Total power generation amount = 440 MW (Fig. 21).

5.5 Proposal of Collaboration between Fisheries and Wind power Generation
The sea is not an everlasting space.
We should understand that the ocean area isn’t just only for the fishing industry.
We have to share our limited ocean area for many purposes. For example, the fishing industry should share the ocean area with the wind power industry.
Wind power generation should prepare spaces for fish farm preservation.
For example, the fish preserve could be set up among the floating triangle structure (Fig. 22).

5.6 Proposal to Apply HAWT for Common Station
- Common station with three HAWTs (Fig. 23).
- Common station with seven HAWTs (Fig. 24).

6. Proposal 2—Proposal of Offshore Wind Farm on High Seas
Use of the high seas for solutions to address population growth.

6.1 Introduction
In the future, as the population grows, the food crisis will increase and it will be essential to secure energy and land.

6.2 Details
The shortage of food, clothing and shelter has become apparent as the population grows, and countermeasures are indispensable.
6.2.1 Increasing Clothing Leads to Increased Clothing Production.
- Land for production is required.
- Power for production and energy such as lighting are required.

6.2.2 An Increase in Food Leads to an Increase in Food Production.
- Agricultural land, hydroponics, and factory land are required.
- Energy such as lighting, heating, and power is required.

6.2.3 Increased Housing Leads to Increased Housing Production
- Land for housing is required.
- Energy for lighting, heating, home appliances, etc. is required.

6.3 Conclusion
It is Necessary to Look for a Place Other Than the Current Land as a Solution for the Increase in Population

6.3.1 Solution
(1) Find another place ⇒ There is no choice but to look to the high seas
- Countries with territorial waters will first set up a farm in the territorial waters and then set up the shortfall on the high seas.
- Countries that do not have territorial waters will set up farms on the high seas.
(2) Energy ⇒ It is necessary to generate electricity over the ocean.
- Countries with territorial waters generate electricity within the territorial waters and generate electricity in the high seas for the shortfall.
- Countries that do not have territorial waters generate electricity on the high seas.

6.4 Rights of All People and Nations on Earth
(1) Everyone on earth has the right to get energy and food supplies.
(2) All countries on earth have the right to get energy and food supplies, with or without territorial waters.
(3) Every country on earth has the right to operate a system (farm) that produces energy and food, with or without technology and experience.
(4) Regarding the operation of Energy & Food Production Farm, the staff of the Energy & Food Production Promotion Organization on the high seas will provide guidance and training as necessary.
(5) All countries on earth can set up energy & food production farms if they have the funds and staff to operate energy & food production farms.
(6) Countries participating in Energy & Food Production Promotion Organization on the high seas can acquire various technologies by dispatching staff to Energy & Food Production Technology Organization at Ocean.
(7) Offshore Energy & Food Production Technology Organization builds technical partnerships with universities and research institutes around the world.
(8) Important projects handled by Energy & Food Production Promotion Organization on the High Seas will be discussed and finalized at the United Nations.

6.5 Proposal
6.5.1 Basic policy
Propose the use of the high seas for energy and food production.
- All countries can use the high seas for energy production and food production.
- The high seas are the Pacific Ocean, Atlantic Ocean, Indian Ocean, Arctic Ocean, Antarctic Ocean, etc.
- The size of the place that can be used on the high seas is determined in proportion to the total population of the country.
- The area of the place that can be used in the high seas in the country that has the territorial waters is the area determined by subtracting the area that can be used in the territorial waters from the total population.
- Countries that use the high seas need to use a pre-designated place.
- Countries that use the high seas need to properly manage the places where they are used.
- Management includes technical content and security management.
- Countries that use the high seas must pay the high seas usage fee. The usage fee is proportional to the area used.

6.5.2 Proposal of HSEFPPO (High Seas Energy & Food Production Promotion Organization)
Countries that use the high seas will set up a specialized organization as a subordinate organization of the United Nations.
Organizations name: (HSEFPPO)
This organization is composed of representatives of countries that support energy and food production on the high seas.
This organization controls all operations related to the operation of energy & food production farm on the high seas.
The area that can be used on the high seas is proportionally determined in this organization according to the ratio of the total population.
The area and location of the energy & food production farm installed on the high seas will be determined by this organization energy & food production promotion organization on the high seas.
Countries that use the high seas can use various technologies used in the high seas fairly.
The cost of energy & food production farm used on the high seas should be covered by the budget of each country.

6.5.3 Proposal of OEFPTO (Offshore Energy & Food Production Technology Organization)

Energy & Food Production Farm is the technology development department of Energy & Food Production Promotion Organization on the High Seas. The name is Ocean Energy & Food Production Technology Development Organization, and development is promoted as a common technology.

Offshore Energy & Food Production Technology Development Organization is mainly engaged in technology development with the participation of engineers from the participating countries of Offshore Energy & Food Production Promotion Organization.

Offshore Energy & Food Production Technology Development Organization is budgeted with support from participating countries.

The system of Energy & Food Production Farm basically uses the system of Energy & Food Production Technology Development Organization at Ocean.

Participating countries can develop their own technology, and if the merit is confirmed in the evaluation on the high seas, the technology can be used in other countries as well.

In that case, it is necessary to pay the usage fee.

6.5.4 Proposal of EFPF (Energy & Food Production Farm)

Energy & food production farm is a common technology used in territorial waters and high seas.

6.5.4.1 Configuration

1. Buoyancy structure
   - Triangular coupling buoyancy structure
   - Multi-coupling buoyancy structure
   - Farm integrated buoyancy structure system
2. Energy production
   - Wind power generation, wave power generation, current power generation
3. Energy storage
   - Storage, hydrogen production
   - Food production
   - Fish farming, aquaculture of seaweed, oyster farming
   - Production of vegetables
   - Food storage
   - Frozen storage, canned
   - Management area
   - Safe operation management
   - Technology development management
   - Residential area
   - Maintenance area
   - Security area
   - Anti-piracy measures, etc.

6.5.4.2 Installation Area (Tentative Plan)

1. Installed in the Pacific Ocean
   - Northeast pacific, northwest pacific, southeast pacific
   - Southwest Pacific
2. Installed in the Atlantic Ocean
   - Northeast Atlantic, Northwest Atlantic, Southeast Atlantic, Southwest Atlantic
   - East Indian Ocean, West Indian Ocean
3. Installed in the Indian Ocean
   - Arctic Ocean
   - Antarctic Ocean

7. Summary

We should bear in mind that we have a serious responsibility for securing and providing energy and food for the current and future generations.

In order to achieve this, the author has developed and evaluated various designs, prototypes, and evaluations for more than 20 years.

The author will report the result.

The author sets the elimination of friction and wears as the first goal in the trial production evaluation of the (flip-up VAWT). As a result, the author confirmed that the (flip-up VAWT) can maintain rotation and generate electricity without using a brake, no matter how strong the wind. Although the evaluation in the super flip-up
mode with a wind speed of 40 m/s or more has not been carried out, the author has confirmed that there is no problem by a tensile test by centrifugal force assumed at high-speed rotation.

The author confirmed that the (flexible parallelogram-coupled triangular buoyancy structure) was not destroyed under huge waves, the verticality of the wind turbine axis was maintained, and stable rotation was maintained.

As a result of the trial production evaluation of the above three wind turbine cooperation buoyancy structure for many years, it can be easily inferred that stable power generation can be maintained without being destroyed even in conditions such as strong typhoons and hurricanes.

However, at present, there are no large-capacity VAWTs on the market anywhere in the world. Only the horizontal axis wind turbines are on the market.

If the aim is to put it into practical use at an early stage, the connection between the horizontal axis wind turbine and the flexible parallelogram connecting triangular buoyancy structure should be tried until the large VAWT is put into practical use.

For floating offshore wind turbines, the high seas are the only remaining area that all countries and people on the planet can use fairly.

All countries and people on earth have the right to benefit from energy and food production in the high seas, with or without territorial waters.

For the above purpose, the author would like to propose the establishment of (World Offshore Energy & Food Production Organization) as a subordinate organization of the United Nations.

World Offshore Energy & Food Production Organization manages all operations related to Production of Energy & Food on the high seas.

World Offshore Energy & Food Production Organization can and should involve all countries and people on the earth.

World Offshore Energy & Food Production Organization is in charge of the following areas.

- Energy: solar power, wind power, wave power, tidal power, etc.
- Food: aquaculture of fish, shellfish, oysters, seaweed, etc.

World Offshore Energy & Food Technology Organization will be established as a subordinate organization in charge of technology development of World Offshore Energy & Food Production Organization.

World Offshore Energy & Food Technology Organization consists of the participation of universities and research institutes around the world.

The activities of World Offshore Energy & Food Technology Organization are as follows.

- Set themes for universities and research institutes around the world and outsource research.
- World Offshore Energy & Food Technology Organization will establish its own research institute to promote research.

The research institute staff of World Offshore Energy & Food Technology Organization is as follows.

- Adopted independently by the institute.
- Dispatched from universities and research institutes around the world for a certain period of time according to the research theme.

We should do our utmost to prevent countries and people around the world, especially children, from suffering from sad situations such as starvation due to lack of energy and food.

The author would like to propose the power generation farm of the combination of flip-up VAWT s and flexible parallelogram-coupled triangular buoyancy structures installed on the high seas to solve the above very important problems.

The author plans to propose the concrete concepts for offshore wind power generation systems on the high seas in the near future.

The author wishes to exchange opinions with those who have questions and comments. If you would like to discuss anything with the author, please send an email to: tatsuhiko.nagata@hb.tp1.jp.
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