

STUDY ON THE PROJECT

BOLO-WIND

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The program of The United Nations for the Departments of Environment says that Oceans are “the greater solar collectors of the world” and that, because of this and other reasons, they are “the greatest warehouse of energy”.

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Energy without limits

INTRODUCTION:

Reminder of the power situation in Spain, applicable in general to many other countries:

- Lack of own primary power plants.

- Dependence on petroleum. Serious political instability in the producing countries, affecting the price very diverse and uncontrollable factors, apart from the progressive increase of the demand.

- Although the gas production is getting increased, its provision is concentrated and fragile. Strategically it is not appropriate to depend on it.

- Paralization of nuclear production from 1993 and the decision to dismantle it.

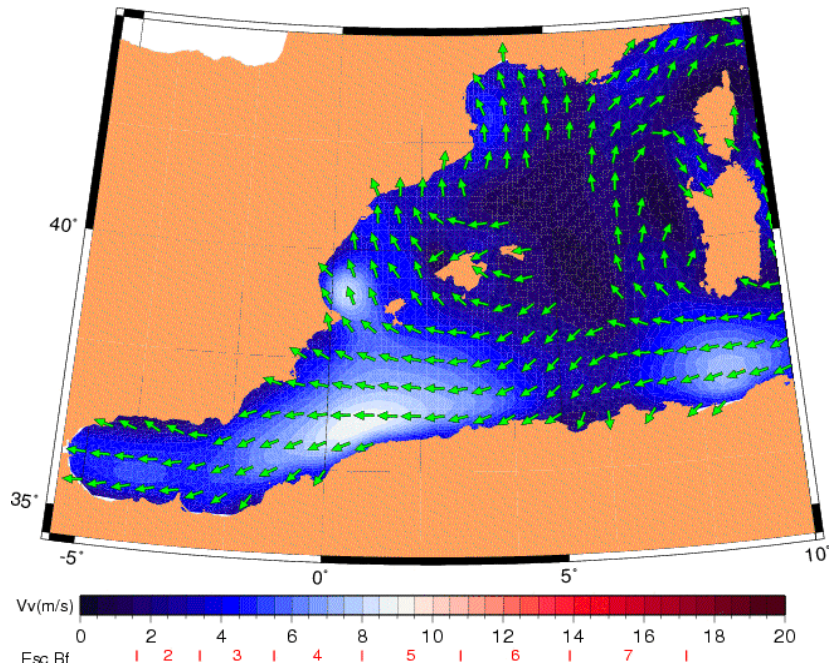
- Kioto: its fulfillment will affect to competitiveness and employment.

- Billionaire exit of currencies.

- Instability in power costs, what produces economic crises at world-wide level. In the internal scope it generates indirect costs given that it initiates inflation.

And in this situation Spain is probably one of the worse positioned countries.

What primary power plants does Spain have as to satisfy all the national consumption?



Starting point:

- Spain is a country that does not have any own primary power plant potentially able to satisfy the present electrical power consumption.

- It is the second world-wide Aeolian power, with two thousand kilometres of coast, and it does not have installed any Aeolian generator in the sea.

- Marine Aeolian energy is considered like an extension of the terrestrial one, ignoring, to say it somehow, that the sea exists. It seems reasonable to think that when the resources are different, the solutions should be different.

If we turned upside down the previous exposition:

- Spain has indeed an own primary power plant potentially able to supply all the demand, and in addition it is renewable. It is real and it is called Aeolian energy, but not only the one that takes place on earth. This energy is in all the territorial sea and in our exclusive economic zone.

- We have really got seas and therefore the improving mechanism has to be adapted necessarily to the resources; it is

necessary to turn favorable something that could be thought to be a disadvantage.

The Spanish territorial sea is deep and therefore an unsalvable obstacle for the anchorage in the marine bed. The only form to be able to accede to all this marine surface, is an installation in the surface.

Spain has a very serious problem power because of its outer dependency, having 600,000 km² of Aeolian energy offshore, that besides are but the suitable ones (as for wind speed, continuity and previsibility). And if we thought about the Iberian Peninsula as a whole, it amounts up to over 1,000,000 km². The only power plant that Spain has is in the sea, taken as a whole, and it is there where we have to go and look for it.

Current technological development

The exposition of a new model of Aeolian production, as opposed to the current one, with a development and a knowledge that are near the technological perfection, and with a dependent industry in exclusive right of this model, produces an unconsciously irrational rejection automatically.

Energy production is not a problem that is stabilized and for which Aeolian energy has contributed solutions with more or less success.

Consumption will progressively continue to increase, much more than the Aeolian development can contribute. And this is thus because of the technological limit to which it has arrived.

In order to manage to overcome that rejection it is essential to convince ourselves that with the present power evolution a new model is necessary, a model that has a great potential of development to be able to solve the problem at the rate that this problem is growing. Paradoxically, this obstacle is the great advantage of the model raised here.

The project of Aeolian machine Bolowind that is exposed next, adapts perfectly to the very instability of the surface of the sea: it is suitable for its massive installation in any point of the sea, being the depth of waters irrelevant.

The predicted utilities are:

- Generation of Electricity.**
- Water Desalination.**
- Elaboration of Hydrogene.**

The natural characteristics of this system allow several configurations: from a system of maximum benefits and the greatest Cost of Inversion/Kw (CoE, Cost of Energy), to simple systems in which the CoE is inferior to the one of the terrestrial Aeolian energy, and, by all means, to the current facilities of Aeolian energy offshore.

ENGINEERING DETAILS AND DATA

Foundation and exposition:

We will avoid calling it a “wind mill” because the foundation has more to do with the operation of a chain dump, in this case an Aeolian one, than with a traditional mill. In the water chain dump the driving force takes place through the different types of pressure created by the difference of density in water (lower part) and in air (higher part). In this Aeolian chain dump there is just air, reason why we have adapted a system that obtains basically the same result, that is to say, the frontal attack of the wind and the high pressure in the higher semicircle and a null resistance in the lower one.



In the attached DVD you can observe with detail the operation, as well as images of it in the tests we have done.

Scheme of the essential characteristics that can be observed:

- Wind direction and transmission of the turn in the same direction. This characteristic allows us to extend the axis, extending thus the yield surface or attack of the wind. It also allows us to join several prototypes, in such a way that their length is not limited.

- The four pairs of masts support the shovels independently of these ones, so that without affecting the yield they can be reinforced among them, forming a hollow prism of great resistance, supporting all the masts the exerted force on the one which is in the attack position at any given time. In the display and the images of the prototype it can be observed that they have been reinforced with

bars, having formed an angle and with steel cables in the outer part. In this way the shovels can easily be extended with a high resistance when talking about great prototypes.

All the elements are anchored in two points, both the main axis and the shovels. This lends it much more resistance, letting it to perfectly support the inertia produced when locating it on an unstable surface that oscillates (a floating platform on the sea).

Prototypes and yield:

Two prototypes have been made:

- 1) BW-1, of 12 metres of height (left image),
and
- 2) BW-2 (on scale), of 2 metres of height.

The attack of the wind takes place frontally by friction.

As it is possible to observe in the video-tape, each shovel turns 90° twice in each return when coming through the horizontal line, which locates them on an attack position or at a maximum resistance in the higher part and at a minimum resistance, or flag position, in the lower one. The

turn is produced by 8 air pistons (one by each shovel) at a pressure of 2 kg/cm², regulated by 8 electrovalves.

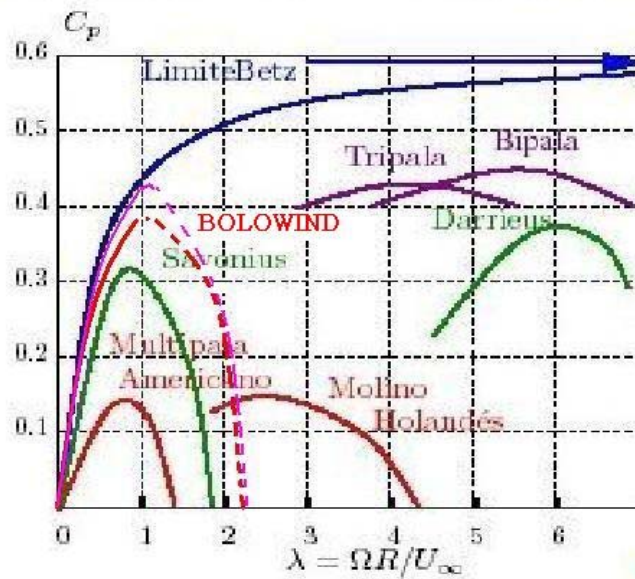
Tests of power:

The instruments used to determine the yield have been: anemometer, tachometer and transducer of dynamic pair, all electronic ones and of high accuracy.

The Coefficient of Power (Cp) obtained is 0.37-0.38 for a value of lambda = 1.

The curve of power included in the graph corresponds to these results from lambda = 0 to lambda = 1. From the value lambda = 1, the drawn curve is an estimation (discontinuous line).





Since the collected data correspond to the first tests made and it is evident that there is an ample margin to improve these results, it is very possible for this system to reach the maximum C_p (0.44) for $\lambda = 1$.

These tests show several conclusions:

- Bolowind will turn 4 times slower than the three-blade model, with an axis torsion pair of, approximately, 3.5 times higher.

- **This regime of RPM is but the most suitable one, since it reduces to the minimum the fatigue and the vibrations that the structure has to support. The increase in the cost of the multiplier is perfectly justified by the benefits that it produces.**

- The maximum power is produced in the bracket of values for λ between 0.95 and 1.20.

Tests of structural resistance and vibrations:

With the flag shovels on flag position (stopped), the prototype has been put under 120 Km/h winds (34 m/s). The result has been excellent: It has perfectly passed the test with no vibration or considerable instability.

Design of a practical example:

It corresponds to the virtual display included in the DVD.

Image 1: Elementary

design of what it would be a project for masts of 30 metres in length. The floating platform has a catamaran form, with the intention of having the maximum stability, with a width of 65 metres so that the two installed parallel units can turn. As you can notice, the first one would

receive the wind in the higher part and would pass freely through the lower one. The direction of rotation would be in opposition to the clock needles. The second one would receive the attack of the wind in the lower part, turning in the sense of the clock needles.

In the theoretical example proposed (400 metres in length by 30 metres of masts), it means a continuous surface of wind frontal attack of 12,000 m² each one, being the total sum of 24,000 m². The area of sweeping for both is 48,000 m².

Generated power: ($C_p = 0.37$).

Wind speed	KW		Wind speed	KW
4 m/s	696.19		10 m/s	10,878.00
5 m/s	1,359.75		11 m/s	14,148.62
6 m/s	2,349.65		12 m/s	18,797.18
7 m/s	3,731.15		13 m/s	23,898.27
8 m/s	5,569.54		14 m/s	29,849.23
9 m/s	7,930.06		15 m/s	36,713.25

****Estimations for a uniform wind speed in the sweeping area. When increasing the wind speed because of height, the real yield would be higher.*

Image 2: Upper view. With a circular turn, being the centre the anchorage at the bottom of the sea, the platform would be oriented, for any wind direction, to its natural position.

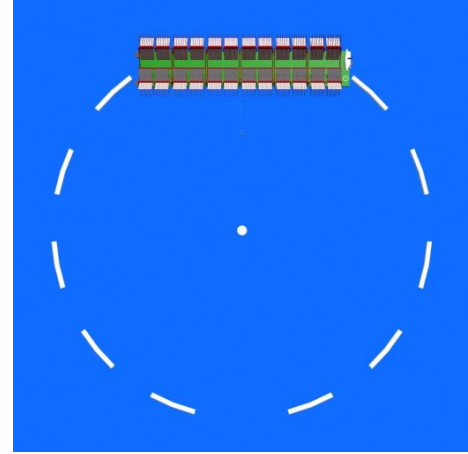


Image 3: It details the view from the prow with both systems installed. Several moorings between the different masts are detailed to give robustness and to get that the supported force that it receives from the attack of the wind at every moment is supported by the four pairs of masts simultaneously. You can perfectly notice the contrast in the position of the shovels, the higher part on the one hand and the lower part on the other.

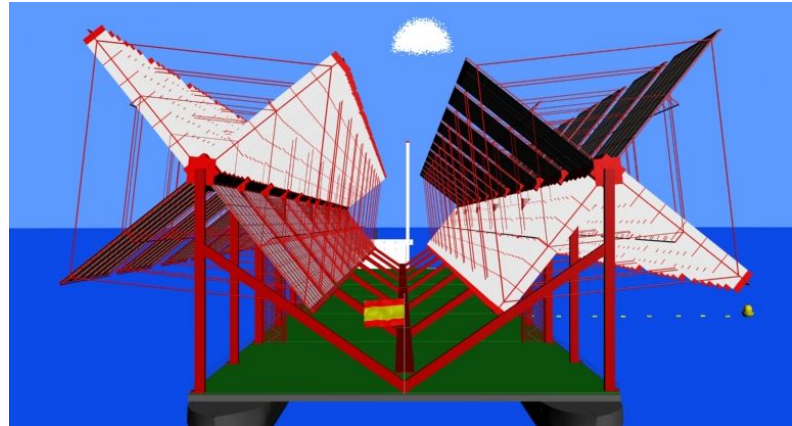


Image 4: In this image the angle that is taken is port, simply with the platform. The anchorage that is detailed would consist of a steel cable tightly hold to the bottom of the sea, and which at the suitable distance would be divided into two, forming a “Y” until arriving at the platform (in red color; the central yellow one corresponds to the electrical evacuation). In this way the same wind force and the waves would place and maintain the platform in the natural position (perpendicular position to the wind that goes through the centre of the imaginary circumference that it would describe).

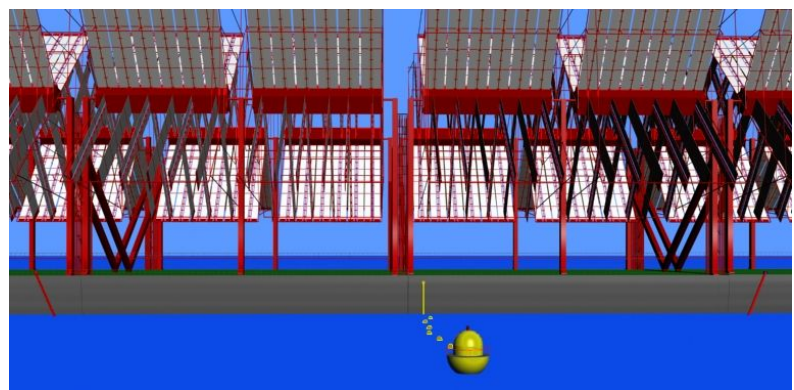


Image 5: Lateral view of the anchorage to the bottom of the sea.

The red cables of fastening are divided, arriving two to the platform and one to the main buoy. The electrical conduction (yellow) arrives from earth, passes through the fastening point, arrives directly at the buoy and later it connects with the platform in the center.

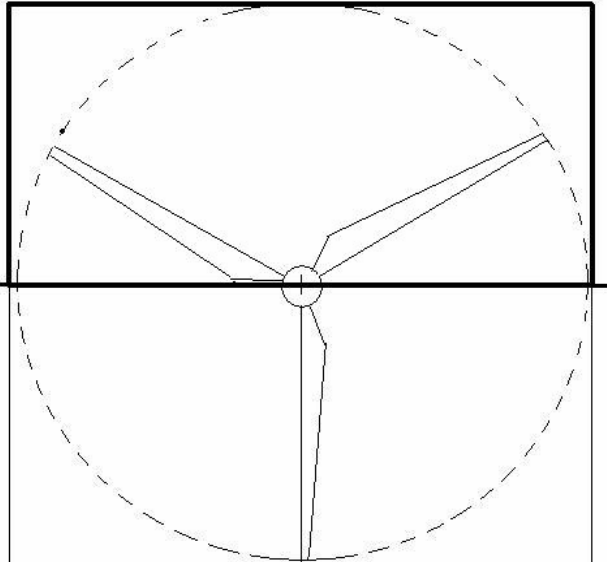
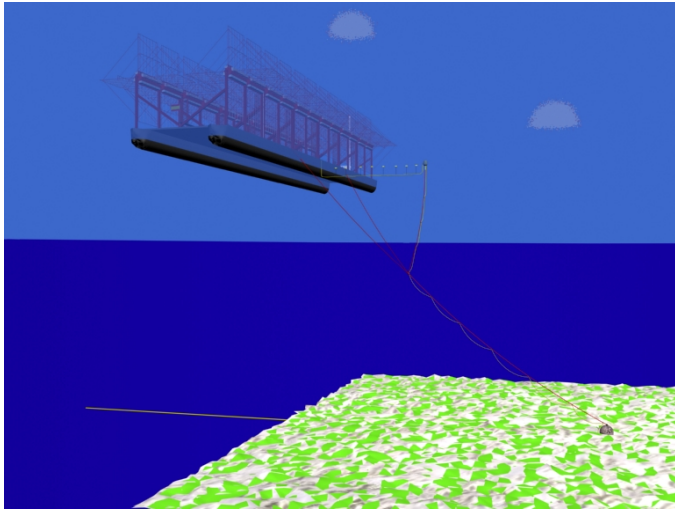


Image 6: Superposition of a three-blade mill on an Aeolian chain dump, corresponding the upper rectangle in bold type to the surface of attack in the chain dump. Comparing both surfaces the proposed model increases 27.39 % the efficiency through a better exploitation of the space.

The display included in the attached DVD tries to summarize with images all the aspects of this exhibition, extending very interesting aspects with the purpose of proposing a global exposition, being essential its visualization.

CORROSION: A SURPASSED OBSTACLE

Corrosion is a consubstantial problem for the marine environment, having a greater incidence in this project that tries the installation very far from the coast and that has at a short term a direct incidence on the operation of the whole system and on the costs, affecting to the economic and functional viability. Conscious of its importance, which can condition the viability of the project, it is essential its elimination as it is detailed next.

Not all the parts exposed to corrosion are affected in the same way. The proposed system allows to effectively protect the maximum elements and specially the most sensible parts. Only the most resistant and essential ones would be exposed to corrosion. The parts that we can protect are divided into two groups:

- Control mechanisms of the working surfaces that are located around the spin axis (control computer, system of turn, filters and collection system).

- All the systems of control and transformation into electrical energy that are located from the point in which the axis exceeds its strongpoints.

As for the first ones (control mechanisms):

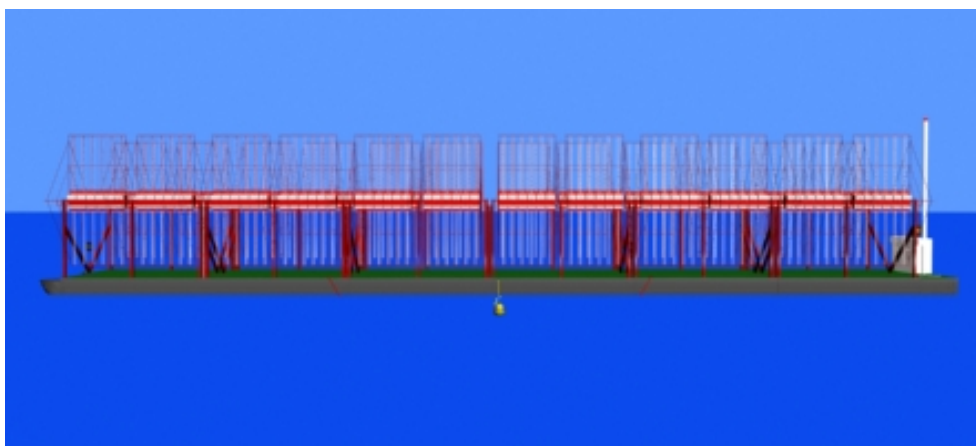
To get that the shovels can carry out the turn they must be separated from the axis at a distance that varies according to its width. Thus, an imaginary quadrangular prism is formed, equidistant from the axis, and delimited by the width of the shovels and with a length that depends upon the length of the axis. In that space all the enumerated mechanisms are located comfortably. As a structural element it is red (virtual display).

In order to protect all these parts with effectiveness it is necessary to close physically and hermetically the described imaginary prism. To put it into practice is very simple and effective.

In this area only the lateral supporting structures would be exposed, the ends of the axis with its covered cockpit, the masts, the axes of the shovels and the material of these shovels. They would be the most resistant parts to corrosion and their components are currently amply proven in the nautical sector.

As to the second ones (control and transformation mechanisms):

The axis would transmit the turn through a gear of a 90° elbow that, by means of a transmission axis parallel to the fastening structure, would arrive at a qualified cockpit hermetically closed in the warehouse of the platform. Inside it all the elements of control and generation would be located, perfectly protected. This proposal of solution has a simple conception, is perfectly viable and tremendously effective, apart from helping the workings of control and maintenance. **Structurally it is also very positive to move the center of gravity to a lower level, which confers a greater stability.**



COSTS

Structure:

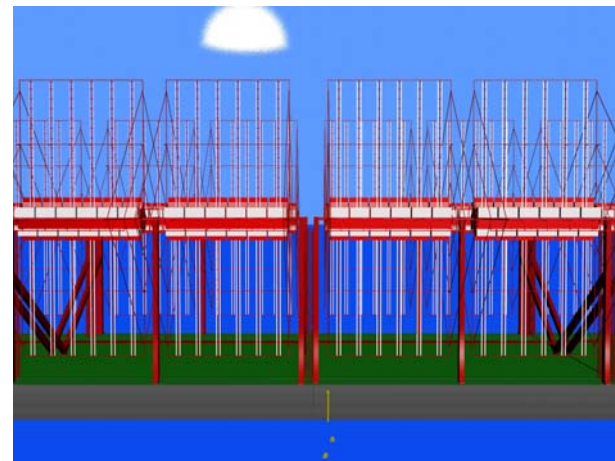
The structure that supports the shovels that gather the energy does not need specially light materials and of a high resistance, due to the capacity of reinforcing between the different parts and because fastening is always made on two points. Its cost would be far below. Weight is not determining in yield, being smaller the fatigue of materials. In this respect the Cost of energy, CoE, would be quite inferior to the shovels of the three-blade aerogenerator.

Electrical connection with earth:

The cost of the investment in this section would also be inferior. Although the electrical laying would be longer when moving away from the coast, once arrived at that point the connection between several platforms would be shorter thanks to power being generated in a very concentrated way. With respect to the other two applications that seem more interesting to us, desalination of water and hydrogen production, being storable products this investment is not absolutely necessary.

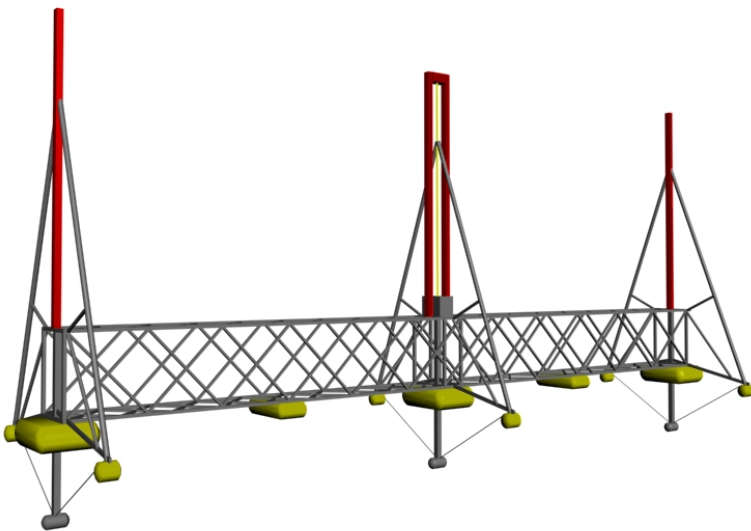
Floating platform:

It is very difficult to determine without specific data the relation that there is between the costs of laying the foundations in the sea and the cost of the platform, although it seems reasonable to think that it can be inferior in terms of CoE.



The system exposed until this moment is a conceptual exposition of maximum benefits. The structure of the Bolowind system allows several options. In chapter 24 of the display you can find a proposal in which the benefits are reduced, mainly mobility and its utility (electricity generation exclusively), reducing CoE drastically:

- It is a floating support thought to be permanently anchored in the same location.
- Unlike the previous design in which benefits are prioritized, in this one the Cost of Energy has been firstly considered.



- The mechanisms of collection of the shovels have been suppressed, simplifying the structure that supports the system. The shutdown system consists in the individual control of the shovels, changing all of them to the flag position (parallel to the wind direction).

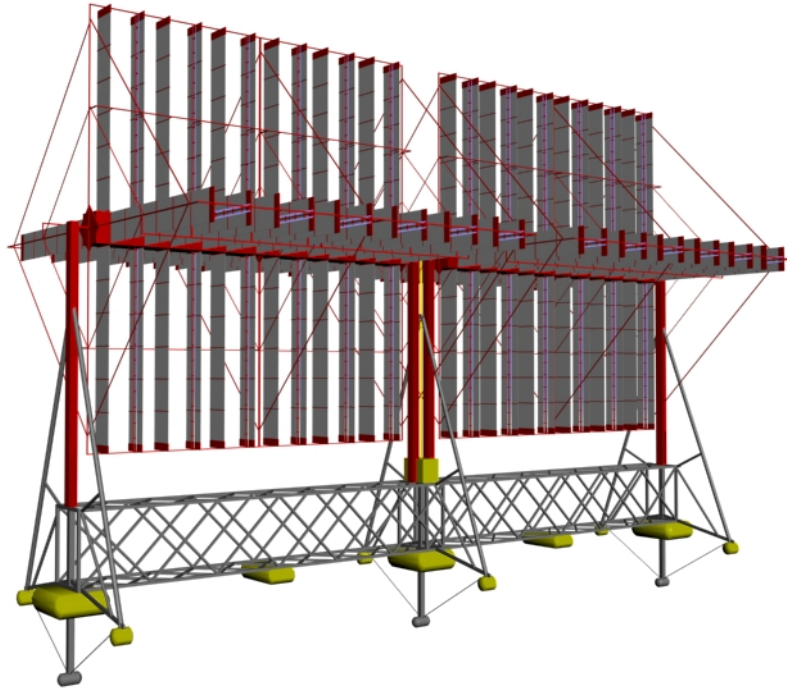
- One of the parallel systems is eliminated, because this design does not allow it.
- The length of the shovel can be increased without any limitation.

The Costs per KW are inferior to the current expositions of Aeolian offshore, and even of the terrestrial Aeolian energy.

This new model we propose has the following characteristics:

Length of shovel: 50 meters

Length of the structure: 400 meters.



Generated power: ($C_p = 0.37$)

Wind speed	KW		Wind speed	KW
4 m/s	580,16		10 m/s	9.065,00
5 m/s	1.133,13		11 m/s	12.065,52
6 m/s	1.958,04		12 m/s	15.664,32
7 m/s	3.109,30		13 m/s	19.915,81
8 m/s	4.641,28		14 m/s	24.874,36
9 m/s	6.808,39		15 m/s	30.594,38

****Estimations for a uniform speed wind in the sweeping area. When increasing the wind speed because of height, the real yield would be higher.*

Paying-off:

The platform length-life has to surpass 60 years, being considered approximately 15 years for the production systems. In spite of that, it is necessary to mention other aspects with a significant economic incidence that it would be necessary to consider for the calculation of the Cost of Energy and that will be developed in the economic chapter of this study.

ECONOMIC VIABILITY

Once understood the operation system developed in the previous chapter, probably we would reach the conclusion that, independently of how we value this exposition like a positive idea, it would not have in itself sufficient entity as to be an alternative to the current system: a new business area versus a very well studied, evolved and consolidated business.

Objectively we have a system that, in principle and with the data that we have today on patents, is original, has the capacity to transform the kinetic energy of the wind into mechanical energy, and given its structure it perfectly supports the inertia that takes place on a floating platform in the sea.

Previous chapter is fundamentally instrumental, describing some means to obtain an aim. **In this section it is determined what those instruments give us and whether they constitute an alternative argument sufficient to be viable:**

- Installation in the sea without limitations
- Free election of location
- Dynamic Mobility-Management
- Metereologic predictions
- Flexibility-Quality: control is everything
- Connection to the mains supply
- Environmental effects
- Elimination of expenses and post sale market
- Special markets
- Immediacy
- Structural resistance
- Estimations.

Installation in the sea without limitations

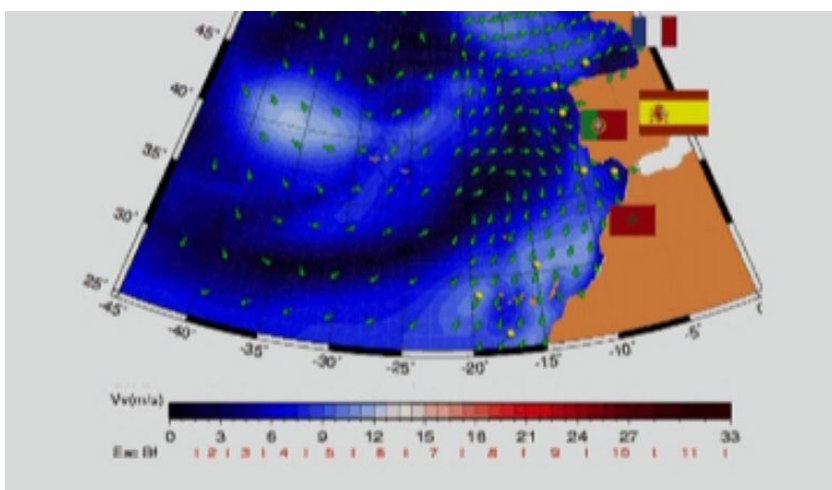
The structure of the described system is thought to support the wind force, the centrifugal force of the turn and the inertia produced by the very movement of a floating surface. It is evident and it does not need more commentary, than a floating platform can be installed in any point of the sea, without other limitations than the economic ones derived from the distance. The Iberian Peninsula has a territorial sea and an approximated exclusive economic zone of a million square kilometers. This area is increasing limitlessly.

Free election of location

Although it is a consequence of the previous argument, its importance deserves a separated mention: we can choose the most suitable zone, without limitations, as far as speed, wind continuity and space is referred.

Mobility – dynamic management

In the previous enumeration of arguments, this one is in bold type with the intention to emphasize its importance and newness: **The introduction in the Aeolian production, through the mobility of the platform and therefore of the production unit, of a model of active management versus the totally passive character of the current model.**



In order to install this system it would be necessary to previously create several groups of buoys in the points of the sea selected. The cable of connection to the network would arrive from earth to the buoy, that in its turn would be anchored by a steel cable to the bed of the sea. The

platform would approach until the buoy, would make the connection

to the network cable and to the fastening cable. This operation would be designed so that it was agile and fast. There would have installed more buoys than units to allow the transfer from one point to another one.

Transferring a production system from a location, during a period in which the average wind speed is 5 m/s., to another point where wind speed is 10 m/s., the yield is multiplied by eight.

We have just introduced the active management of Aeolian energy. This, at the present time, is the true revolution of Aeolian energy, the definitive step. Until now the management of Aeolian energy has been totally passive, with the hope that the wind will blow. Wind predictions only help to forecast production, but they do not have any incidence in production. With this system predictions, that in the sea are easier and more trustworthy, would contribute to the increase of yield, and the more these predictions are developed, the more possibilities of an effective productive management will be.

The second proposed model, although has less benefits in this aspect, is movable too.

We insist on the necessity of a reflection on the possibilities that a dynamic, professional and specialized management would have on the final results.

Meteorologic predictions

The meteorologic prediction applied to Aeolian energy facilitates to previously know the power that is going to generate the Aeolian park. Its importance is such that the efforts in this field have been augmented to their maximum advantage. But these models of prediction are useful mainly to prevent the connection problems to the network.

The complete utility of this tool will only take place when it contributes with more production. It is the indispensable complement for a dynamic management and this can only take place in a movable mount.

Flexibility-Quality: Control is everything

That is to say, a total control on the amount and quality of the produced energy. The attack surface is divided into units that are controlled individually and in an instantaneous way, allowing to eliminate counter-productive tips of production.

One of the characteristics of wind is its discontinuity. Although in the sea they are more continuous, there also exist precise wind variations.

These unexpected ascents produce tips in the generation that originate problems in the network, being essential their elimination or at least their reduction. It is a serious problem that this proposal eliminates totally, increasing the quality of the produced energy.

Whereas an aerogenerator cannot control the energy that it produces, this model has as a characteristic that the attack surface is divided into independent shovels that can be controlled individually and in an instantaneous way, allowing the total control on the energy that is wanted to produce in a certain period. This aspect is made perfectly clear in chapter 17/25 of the display.

Handling the instantaneous control of the shovels, it is possible to generate the same amount of energy independently from the increasing of the wind speed in a temporary and unforeseeable form.

Shutdown in extreme conditions

It is sufficiently documented that similar systems in their essential characteristics (Savonius type) have the advantage of producing energy at very low speeds of wind. Given the structure described in the first part, this prototype widely surpasses the maximum limit of cut speed. But meteorological circumstances with extreme wind speeds occur in which the shutdown of the system becomes necessary.

This problem seems even more important than corrosion: corrosion affects the maintenance and life utility, but the problem that is considered in this section can destroy the system.

Deliberately and partly to expose the problem in its entire dimension the measures of the example were settled down. The total surface exposed to the wind, with greater or smaller incidence, is of 96,000 m² for the first proposal and 80,000 m² for the second one.

In an extreme situation there is an elevated risk of an uncontrollable situation, reason why it becomes necessary to implant a protection system.

This protection can be made in two ways according to the chosen model:

In the first model, **the one with maximum benefits**, a system of collection of the shovels is set out.

Although in the prototype and in the designs axes of simple shovels can be seen, to solve this problem it is foreseen a special design with several fastenings distributed along its length. This form of fastening has been described as original by the Spanish Office of Patents and Marks, having not found in the Report of International Search any document considered relevant.

This design would gather the 96,000 m² in less than 2 minutes, locating it completely fitted around the central axis and perfectly protected. This possibility is informed perfectly in the virtual display.

In the **simplified model**, the system would place all the shovels in less than 10 seconds on a flag position (parallel to the wind direction).

Connection to the mains supply

Aeolian energy causes problems in the mains supply when being spilled to it, originated by its unpredictableness and its discontinuity, in such a way that it is discussed the amount of Aeolian energy that the national mains supply is able to admit. The previous arguments facilitate and allow to improve that coefficient in an

effective way acting on them. This is a very important problem in the mid term that this system can solve totally.

Environmental effects

This project eliminates the environmental questions totally, something which because of its social repercussions is of the highest importance. It also eliminates the indirect associated costs.

Elimination of expenses and post-sale market

The installation in the sea eliminates the real estate rents, municipal rates, taxes and wills; the indirect costs originated by delays in authorizations, projects and social demonstrations. Besides, the costs derived from the different autonomic legislations with particular obligations. Finally, the final costs for the withdrawal and reconstruction of the surroundings.

And as opposed to this situation, this project allows the return of the capital, eliminating the costs of withdrawal. It is unquestionable that a useful unit will have a value in the market. The only necessary point is to move it.

It is possible as well to move the units to locations where there is a greater demand or a greater repayment of the produced energy.

Special markets

One of the opinions that all the experts consulted have repeated with respect to the viability of the project has been the relation between the costs of the investment and the KW installed (Cost of Energy, CoE).

Given the difficulty to determine it in an exposition like this one, it is expedient to make some reflections: because of its structure, this system does not require the use of the most technologically advanced materials, having enough margin in this area. There are real possibilities for this cost to be lower than the present one.

On the other hand, supposing that it surpassed it, it would still be useful and would come to cover certain hollows or market necessities: there are specific situations in which the relation cost-Kw has a residual character. In these cases the main point is not the cost, but the resolution of a problem. The most characteristic examples would be Spain and Japan, this last country with a really wide Economic Exclusive Area, with an enormous Aeolian potential, over-populated, with no own energy resources, very well developed and with sufficient economic resources. The primary target would be to reduce the outer energetic dependency, the true problem, being the CoE a secondary and relative one.

The supplying of tourist zones, islands mainly (Canary and Baleares are near examples).

Water desalination: the platform is sufficiently wide as to install a desalinating plant. Out to sea the brine would stop being a problem. In all these and other special situations a significant sobrecost would be secondary if it solves a problem satisfactorily.

Immediacy:

In all the project there is, in principle, no unsalvable obstacle technically, that is to say, it can be made immediately.

Structural resistance:

The speed of cut of an aerogenerator, so as to avoid damages, has the maximum limit of 25 m/s. According to the behaviour in the test described in the previous chapter, it is possible to obtain generation up to speeds of wind of 40 m/s. (Remember the regime of RPM with which it works, pages 12 and 13).

Estimations

In order to determine the relation Cost of Investment/Kw, it is necessary to make an estimation of the increase of the production that would be obtained in marine locations. It would depend on two variables: increase of the speed and the continuity of the wind.

An increase in the speed of 60% increasing the load factor to 70% would approximately suppose to multiply by 20 the production in Kw/hora in every annual period. It turns out advisable to consult different models of wind prediction (HIRLAM) in www.inm.es (Web Page of the National Institute of Meteorology).

Imagine

It is not a coincidence that the virtual display included in the DVD attached here begins and finishes with this song: it tries to suggest that each addressee of this work studies the proposal, has an active participation, imagines this project, contributing with his/her own ideas, suggestions and opinions, and judges of the results. **It is evident, and we believe that it does not admit doubt, that this proposal is very flexible and allows other shapes.** And it tries to avoid an assessment based exclusively in the visualization of the work, it is improvable in several aspects, and probably some details are not transmitted with sufficient clarity, not affecting this to its foundation and operation.

We present you an ambitious work that has two primary targets: on the one hand, to visually materialize the example included in the first part, **Energy without limits**, and on the other hand, to extend it to a complete and viable project that is able to take us as near as possible to what could reasonably be the reality. With this aim, all the design of the virtual display has been rigorously made on the basis of real data and real measures. During the elaboration process it has been reviewed disinterestedly by Spanish specialists in aeronautical engineering and engineering structures, being included here most of their suggestions and opinions.

The content of the DVD is organized in 27 chapters, to which you can have access in a fast and simple way with the control of your DVD reproducer. They are possible as well to be divided into two groups: until chapter 10 the content is general and focused on the

operation; from chapter 11 the content is more detailed, showing specific aspects.

Engineering data of the holder: PAL video system. Image format: 4:3. Sound: Digital Dolby, stereo, 2 channels. Important note: in order to obtain the maximum quality of image, if you visualize this DVD in the EE.UU., Ibero-America or in the geographic area of the Pacific Ocean, it is possible that you have to shape your reproducer and television specifically, changing the video system from NTSC to PAL-Video.

Detailed description of the chapters:

Chapter 1/27: Beginning of the display. When introducing the disc it will begin automatically.

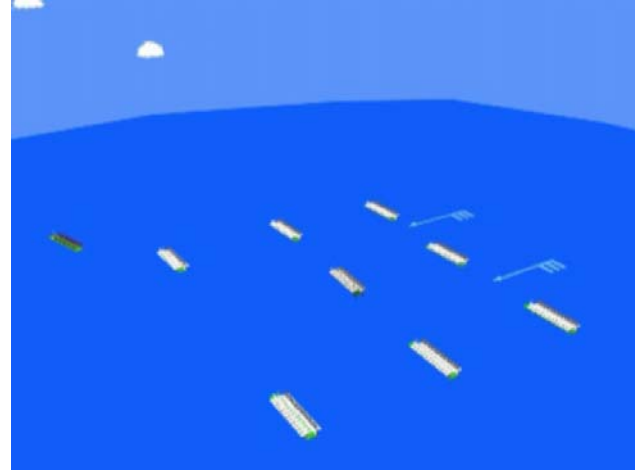
Chapter 2/27: It corresponds to the initial presentation. In it you will find two maps that correspond to the marine zone that surrounds Spain. It can be observed a selection of 18 blinking points, selected depending on their wind conditions, representing the same number of marine Aeolian parks. The maps were taken on the 22nd of July, 2006 and the estimation of the wind speed corresponds to the wind in the surface. Although all the display has been made on scale, in this image takes place an exception: the points do not represent the surface occupied by a park similar to the proposed one in the following chapters, because they would not be visible. Information published in the Web Page of the I.N.M. (Meteorological National Institute):

<http://www.inm.es/web/infmet/predi/metmar/indpuer1.html>).

Making a follow-up of the information published in that web page we can draw two conclusions:

- The wind speed in the sea, far from the coast, is far higher than on earth, including the coastal strip.
- In general it is practically continuous.

Chapter 3/27: Scene that corresponds to a general level of a park made up of nine units. We can observe that one of them approaches sailing to the free position number 2. According to the used scale, the length of each



platform is of 400 metres by 65 of sleeve. The separation in a right angle between platforms is of 1,500 metres and in diagonal of 2,500 metres. The occupied total surface is of 9 kilometers square.

Chapter 4/27: The image is centred on platform number 5, crossing in detail from prow to stern by port. We can observe three points that are going to be a constant in the display and that will help us to get located in every moment, being always visible some of them: prow, with the flag that indicates the wind direction, the yellow buoys that indicate the port position (direction from where the wind blows), and stern.

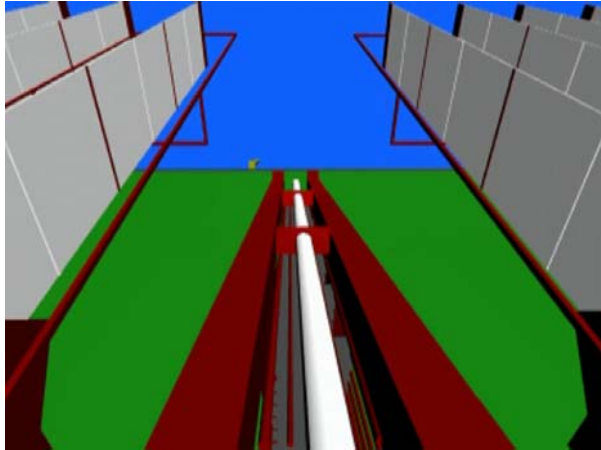
The different parts are simplified, distinguishing them with loud colors. It is interesting that the red one is exclusively reserved for the structural component of the production system. Due to a number of reasons we have assumed that the different systems longitudinally installed are affected by the same wind speed, turning uniformly and simultaneously.

Chapter 5/27: It offers a fore and aft perspective through starboard.

Chapter 6/27: Central route from stern to prow. In the top position we can observe, behind the shovels that are turning, the arrival and connection of another platform to position number 2. The chapter ends up with the opposed position of the shovels at a certain moment, congealing the turn.

Chapter 7/27: It can be surprising that this scene is not acclimated with computers, blinkers and other systems of remote control. As opposed to the isolation characteristic of these systems, we try to transmit and to reinforce the ideas of presence and direct control, proximity, familiarity and habitability; in short, that the

displaced personnel can be in optimal and habitual conditions. In the screen of the computer a summary of the production data is remembered, according to the calculations of the example proposed in Part I: Energy without limits.



Chapter 8/27:

Different takings and route of the axis that transmits the mechanical energy until the warehouse of the platform.

Chapter 9/27: This chapter shows the situation of all the mechanisms and instruments of generation. This place has several advantages:

- A much more light higher structure. Saving of costs.
- It lows down the centre of gravity. A greater stability.
- All the mechanisms are hermetically isolated and protected from the climatic conditions of the sea, mainly of corrosion.
- Amplitude and accessibility for repairs, storage and maintenance.

Chapter 10/27: The scene begins from the outer position where the generators are located. It shows a first plane of the main buoy and several smaller ones. Through these, it is made the anchorage of the platform to the bottom of the sea and the evacuation until the mains supply in earth. Chapter 13 treats these details widely. The end of the chapter shows us the circular movement of all the platforms, having like pivot point the point of anchorage in the bottom of the sea when varying the wind direction.

Chapter 11/27: This chapter is the beginning of the most detailed scenes and specific aspects that need to be remembered. It begins reminding us of the null environmental consequences through two dolphins that go swimming and that will lead us to the bottom of the sea, where platform number 2 is anchored. Following the scale used, the anchorage point would be located at a depth of 230 meters.

Chapter 12/27: The images of this scene are centred in showing the position of the fastening cables from the anchorage point to the platform and the main buoy (in red color), as well as the intake of electrical evacuation (in yellow color).

Chapter 13/27: Continuation of the previous taking. In this case the electrical intake from the main buoy to the platform is shown. Following the scale used, the cable runs suspended at a depth of 8 metres.

Chapter 14/27: General view of platform number 2 before starting to work.

Chapter 15/25: Starting process with the unfolding of the shovels.

Chapter 16/27: Once the shovels are extended and deactivated (parallel to the wind) the starting sequence takes place, activating the shovels of the highest position.

Chapter 17/27: Control of power: the division of the attack surface and the facility of control of the shovels allows that when the wind changes in an unwilling way, one of them, several of them or even all of them can be deactivated, with the purpose of maintaining stable the power that we want to generate. The answer is instantaneous (2 seconds maximum).

Chapter 18/27: General upper view moving away from platform number 2, already operative.

Chapter 19/27: General upper view approaching platform number 1. This is a platform in operation and we are going to contemplate what would be the disconnection process: the shovels are all deactivated (position flag) until stopping the turn.

Chapter 20/27: Once the shovels are stopped the collection sequence begins. The position of collection and extension through which the shovels go, one by one, is the most suitable and it determines the wind direction.

Chapter 21/27: This scene proposes a location to install a desalinating plant or hydrogen factory: others can be set out, and all of them will be superb.

Chapter 22/27: Once the collection process is finished and once the electrical and fastening cables are loosed, the moving towards another location is started.

Chapter 23/27: Continuation of chapter 21.

Chapter 24/27: Alternative proposal of a simple structure for a permanent installation, exclusively designed for electrical generation.

Chapter 25/27: Prototype BW-2 in operation. It is perfectly appraised the facility and the instantaneous control.

Chapter 26/27: Video of prototype BW-1 with several photographs.

Chapter 27/27: Addresses and in-touch information.

FINAL CONCLUSION

All these characteristics that we have tried to enumerate have a great potential of development, and the same as the initial mills were developed exponentially, this system has more aspects able to be developed. Aeolian energy is in the technological limit. If we have the necessity of a great advance, it is possible that we are forced to reframe the situation from the beginning. This exhibition tries to transmit that idea. The benefits justify the effort. The power situation of many countries, the environment, the climatic change, force the urgent Aeolian improvement of marine power, which until now has been practically null. BOLOWIND is suitable for this aim and its possibilities are technically immediate.

We hope that this approach has been of interest to you.

Thank you very much for your attention.

Kindly.

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