

METHOD AND SYSTEM FOR INSTALLING AN OFFSHORE WIND
POWER STATION AT SEA AND/OR TRANSPORTING ONE FROM SEA,
AND AN OFFSHORE WIND POWER STATION

5 The present invention relates to a method as
defined in the preamble of claim 1. Moreover, the in-
vention relates to a system as defined in the preamble
of claim 7. In addition, the invention relates to an
offshore wind power station as defined in the preamble
of claim 11.

10 In prior art, a method for installing an off-
shore wind power station at sea is known from specifi-
cation GB 2327440. The wind power station comprises a
wide base and a tower extending vertically from the
base and carrying a wind rotor mounted on its top. In
15 the installation method presented in the above-
mentioned specification, the tower and the base of the
wind power station are transported as a single assem-
bly by using a floating frame, e.g. barges, fastening
the base to the bottom surface of the barge, trans-
20 porting it to the place of installation and then low-
ering it to the sea bottom using means provided on the
floating frame, such as chains, wire cables, a lever
jack or the like. The floating frame can then be used
for the installation of other corresponding base-tower
25 combinations.

A problem with this prior-art method is that
the load capacity of the floating frame used for in-
stallation has to be so designed that it will bear the
weight of the base and tower in addition to its own
30 weight. The resulting floating frame is very bulky and
expensive. Besides, this specification completely ne-
glects the occasional need to raise the wind power
station from the sea bottom and transport it to
land/ashore for servicing. With equipment built ac-
35 cording to the specification, this would be difficult
if not impossible because the base, which may be made
of concrete or steel, must be very heavy to resist the

stress exerted on the wind power station by the wind, sea currents, waves and ice. Therefore, the base is provided with ballast material of sand, stones or iron ore. Lifting such a load from the bottom requires a
5 very high external hoisting capacity. Therefore, a special open sea crane ship would be needed for the hoisting operation.

The object of the invention is to eliminate the above-mentioned drawbacks.

10 A specific object of the invention is to disclose a method and system for the transportation of an offshore wind power station that will allow transportation without the transport vessel having to carry the weight of the wind power station at all.

15 A further object of the invention is to disclose a wind power station which can be easily transported back and forth between a place of installation and a place of maintenance and which can be raised and lowered independently in water without using any special hoisting equipment.
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The features characteristic of the method, system and wind power station of the invention are presented in the claims below.

In the method of the invention, the wind
25 power station is transported to a place of installation at sea by using a transport vessel and lowered to the sea bottom and/or raised from the sea bottom and transported to land/ashore by means of a transport vessel. According to the invention, the wind power
30 station is lowered by adding ballast water into a ballast water tank provided in the wind power station, and the wind power station is raised by reducing the amount of ballast water in the ballast water tank.

In the system of the invention, the wind
35 power station comprises a base to be mounted on the sea bottom, a tower attached to the base, and a transport vessel provided with a gripping device for grip-

ping the wind power station and transporting the wind power station to a place of installation at sea and/or transporting it to land/ashore from the sea. According to the invention, the system comprises a ballast water
5 tank disposed in the wind power station.

The offshore wind power station of the invention comprises a base to be mounted on the sea bottom, and a tower attached to the base. According to the invention, the wind power station comprises a ballast
10 water tank.

Other preferred features and embodiments of the invention are presented in the subclaims below.

In the following, the invention will be described in detail by the aid of a few examples of its
15 embodiments with reference to the attached drawing, wherein

Fig. 1 presents an embodiment of the wind power station of the invention in a diagrammatic side view and partly sectioned,

20 Fig. 2 - 7 present two different embodiments of the system of the invention and different stages in the procedure of the invention.

Fig. 1 presents a wind power station 1 according to the invention. It comprises a wide base 2
25 of e.g. a round slab-like shape, which can be set on the sea bottom. Further, the wind power station comprises a tower 3 attached to the base and extending vertically from it. Mounted on the upper end of the tower 3 is a wind rotor 9. The box-like base 2, which
30 may be made of concrete or steel, is of a hollow construction and the space inside it functions as a ballast water tank or container 6. The tower 3 is likewise of a hollow construction and the space inside it serves as a ballast water tank 7. The interior spaces
35 of the ballast water tanks 6, 7 in the base 2 and tower 3 may be separate spaces or they may communicate with each other. Moreover, the wind power station 1

may comprise a pump or pumps 8, by means of which it is possible to pump sea water into and out of the ballast water tanks 6, 7. The pump 8 may also be disposed on a transport or service vessel 4, in which case the
5 wind power station need not necessarily be provided with ballast water pumps.

The buoyancy of the wind power station in water is so designed that the station is able to float and carry its own weight in water when the ballast water tanks 6, 7 are empty. Correspondingly, when the
10 ballast water tanks 6, 7 are partially or completely filled with water, the wind power station will sink to the bottom.

In Fig. 2, the base 2 and the tower 3 are assembled on land or ashore into a unitary whole by using a crane ashore. The base 2 can be floated separately to the place of installation and lowered onto a firm pedestal resting on the bottom by filling the ballast water tank 6 in the base. On the top of the
15 base 2, a tower 3 is built from one or more parts. Water can also be pumped into the ballast water tank 7 in the tower to increase its firmness. Finally, a machine room and a wind rotor 9 are mounted on the end of the tower 3.
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When the wind power station is to be transported to its place of installation at sea, as illustrated in Fig. 3 and 4, the amount of ballast water in the ballast water tanks 6 and 7 in the base 2 and in the tower 3 is so adjusted that the base 2 becomes
25 buoyant and is lifted off the bottom. By adjusting the amount of ballast water in the tank 6, 7, the elevation and stability of the base in relation to the transport vessel 4 are adjusted to make them suitable for transportation. The tower 3 is gripped from a lateral direction from opposite sides by the gripping
30 jaws 10 of a gripping device 5 mounted on the transport vessel, as illustrated in Fig. 4. The grip on the
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tower is preferably such that it permits movement of the tower in a vertical direction in relation to the transport vessel but not in other directions. The wind power station is then transported to its place of installation at sea.

Fig. 5 and 6 illustrate an alternative solution for implementing the transport vessel in Fig. 3 and 4. In Fig. 5 and 6, the transport vessel 4 used is a barge 4 having a forked frame with a through slot 11 extending from its middle to the edge, allowing the tower 3 to go through the slot. For transportation, the base 2 can be fastened in a substantially fixed manner to the barge 4. The upper surface of the base 2 lies against the bottom of the barge 4 and is fastened to it by suitable fastening elements 12, such as wire cables, chains, threaded bolts or the like.

Fig. 7 presents a phase in the procedure at which the wind power station has been brought to the place of installation and an amount of water sufficient to increase the weight so as to allow the base 2 to sink to the sea bottom has been pumped into the ballast water tank 6 of the base 2 and into the ballast water tank 7 of the tower 3.

Substantially the entire inside space of the tower 3 constituting the ballast water tank 7 can be filled with water. Providing a ballast water tank in the tower 3 in addition to the base 2, together with an appropriate design, enables the weight of the wind power station to be increased so that it can rest very firmly on the bottom and the wind power station is able to receive the loads generated by wind, sea currents, sea roll and ice, which tend to upset or move the wind power station. Furthermore, providing a ballast water tank 7 in the tower 3 makes it possible to use a base 2 of a relatively light and compact construction.

The base 2 can be provided with water jet equipment (not shown in the figures), by means of which the bottom, if it is e.g. of a sandy nature, can be dredged after the base has sunk against the bottom, thus making it possible to adjust the vertical alignment of the wind power station.

When the wind power station is to be brought ashore from the sea for maintenance, the procedure is naturally reverse to that for installation. The amount of water in the ballast water tanks 6, 7 of the wind power station 1 standing on the bottom is reduced until the buoyancy of the base 2 and tower 3 has lifted the station off the bottom and raised it to a level near the surface. Via the ballast water tank 6, 7, the elevation and stability of the wind power station are adjusted to make them suitable in relation to the transport vessel 4 used for transportation. The tower 3 is then gripped from opposite sides by the gripping device 5 of the transport vessel 4 and the wind power station is transported away from the place of installation to a place of maintenance.

The invention is not restricted to the examples of its embodiments described above; instead, many variations are possible within the scope of the inventive idea defined in the claims.

AMENDED CLAIMS

1. Method for installing an offshore wind power station (1) at sea and/or transporting one from sea e.g. for maintenance, said wind power station comprising a base (2) to be mounted on the sea bottom, and a tower (3) attached to the base, which wind power station is transported to a place of installation at sea by means of a transport vessel (4) and lowered to the sea bottom and/or lifted off the sea bottom and transported to land/ashore by means of a transport vessel, characterized in that the wind power station is lowered by adding ballast water into a ballast water tank (6, 7) provided in the wind power station and that the wind power station is raised by reducing the amount of ballast water in the ballast water tank, the ballast water tank (6, 7) being so designed that the station is able to float and carry its own weight in water when the ballast water tank (6, 7) is empty, and correspondingly, when the ballast water tank (6, 7) is partially or completely filled with water, the wind power station will sink to the sea bottom.

2. Method as defined in claim 1, characterized in that vertical motion of the wind power station (1) in relation to the transport vessel (4) is permitted during the transportation.

3. Method as defined in claim 1 or 2, characterized in that, to install the wind power station at sea, the wind power station is gripped by a gripping device (5) mounted on the transport vessel (4); the elevation and stability of the wind power station are adjusted by the aid of the ballast water tank (6, 7) to make them suitable with respect to the transport vessel; the wind power station is transported to the place of installation at sea; and the wind power station is lowered at the place of

installation to the sea bottom by filling the ballast water tank (6, 7).

4. Method as defined in claim 1 or 2, characterized in that, to transport the wind power station from sea, the amount of water in the ballast water tank (6, 7) is reduced until the wind power station has risen off the bottom to a level near the surface; using the ballast water tank (6, 7), the elevation and stability of the wind power station are adjusted to make them suitable in relation to the transport vessel (4); the wind power station is gripped by the gripping device (5) of the transport vessel (4); the wind power station is transported ashore from the place of installation, e.g. to a place of maintenance; and the wind power station is released from the grip of the transport vessel.

5. Method as defined in any one of claims 1 - 4, characterized in that a ballast water tank (6) disposed in the base (2) of the wind power station is used, and/or that a ballast water tank (7) disposed in the tower (3) of the wind power station is used.

6. Method as defined in any one of claims 1 - 5, characterized in that the tower (3) of the wind power station is gripped by the gripping device (5) of the transport vessel (4) from opposite sides.

7. System for installing an offshore wind power station (1) at sea and/or transporting one from the sea e.g. for maintenance, said wind power station comprising a base (2) to be set on the sea bottom, and a tower (3) attached to the base, and a transport vessel (4) provided with a gripping device (5) for gripping the wind power station to transport it to a place of installation at sea and/or from the sea to land/ashore, characterized in that the system comprises a ballast water tank (6, 7) disposed in

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the wind power station; and that the ballast water tank (6, 7) is so designed that the station is able to float and carry its own weight in water when the ballast water tank (6, 7) is empty, and correspondingly, when the ballast water tank (6, 7) is partially or completely filled with water, the wind power station will sink to the sea bottom.

8. System as defined in claim 7, characterized in that the system comprises a pump (8) disposed on the vessel (4) or on the wind power station (1) for pumping ballast water into/out of the ballast water tank (6, 7).

9. System as defined in claim 7 or 8, characterized in that the base (2) is provided with a ballast water tank (6) and/or that the tower (3) is provided with a ballast water tank (7).

10. System as defined in any one of claims 7 - 9, characterized in that the gripping device (5) of the transport vessel comprises gripping jaws (8) for gripping the tower (3) from a lateral direction from its opposite sides, said gripping jaws being designed to allow vertical motion of the tower in relation to the transport vessel (4).

11. Offshore wind power station comprising a base to be set on the sea bottom and a tower (3) attached to the base, characterized in that the wind power station comprises a ballast water tank (6, 7) being so designed that the station is able to float and carry its own weight in water when the ballast water tank (6, 7) is empty, and correspondingly, when the ballast water tank (6, 7) is partially or completely filled with water, the wind power station will sink to the sea bottom.

12. Offshore wind power station as defined in claim 11, characterized in that the base (2) is provided with a ballast water tank (6) and/or that

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the tower (3) is provided with a ballast water tank (7).

13. Offshore wind power station as defined in claim 11 or 12, characterized in that the
5 wind power station (1) comprises a pump (8) for pump-
ing ballast water into/out of the ballast water tank (6, 7).