

Semi-direct variable speed drive with N+1 power availability

BACKGROUND OF THE INVENTION

Field of the Invention

Embodiments of the present invention relate generally to the field of power systems and, more specifically, to systems
5 for controlling speed of a variable speed motor.

Description of the Related Art

Power systems configured to generate energy and to use the generated energy to drive mechanical equipment or motors are widely used. Furthermore, often it is desirable or required to
10 be able to control the rotational speed of mechanical rotating equipment driven by the generated energy. For example, for a compressor to function properly, the start-up and warm-up speed of the compressor must be carefully controlled to keep process variables within range.

15 A system capable of generating energy and using the generated energy to drive mechanical rotating equipment while controlling the rotational speed of the equipment is illustrated in Figure 1. As shown, a system 100 includes gas turbines GT1, GT2, and GT3. The gas turbines GT1-GT3 are directly coupled to
20 mechanical rotating equipment, such as, for example, compressors CPR1, CPR2, and CPR3. In this type of system, the gas turbines GT1, GT2, and GT3 convert thermal energy of combustion gas into mechanical energy directly used to drive the compressors CPR1, CPR2, and CPR3. One drawback of such a system is low
25 reliability because if one of the gas turbines GT1, GT2, or GT3 breaks down or needs to be taken out for maintenance, the compressor coupled to this turbine cannot function. The gas turbine can be any kind of main driver, i.e. fired engine or steam turbine.

30 As the foregoing illustrates, what is needed in the art is a system for controlling a speed of variable speed motors in a reliable manner.

US 2005/177756 discloses a power distribution system that includes a plurality of loads and a plurality of power

sources. The power distribution system also includes an interconnect arrangement including a plurality of interconnects. The interconnects connect each load to a given number of different ones of the sources so that each load is fully powered notwithstanding failure of any one of the sources.

SUMMARY OF THE INVENTION

One embodiment of the present invention discloses a system for controlling a speed of each of N variable speed motors with a drive voltage, where N is an integer equal to or greater than 1. The system includes $(N+1)$ generators configured to drive the N variable speed motors. The system also includes a switching arrangement configured to directly couple the N variable speed motors to present generators, where the present generators comprise the $(N+1)$ generators, so that any one of the N variable speed motors is capable of operating in at least a first mode and a second mode. In the first mode the any one of the N variable speed motors is driven with the drive voltage generated by a first generator of at least two of the present generators. In the second mode the any one of the N variable speed motors is driven with the drive voltage generated by a second generator of the at least two of the present generators. In such a system, the speed of the each of N variable speed motors may be controlled by modulating frequency, amplitude, or both, frequency and amplitude, of the drive voltage.

The gist of the present invention resides in directly coupling the N variable speed motors to present generators in a manner that allows any of the N variable speed motors to be driven by at least two of the present generators. The disclosed system allows, for example, operation of three different variable speed motors on four generators. As a result, the generators may be operated at $(N+1)$ availability, which leads to an increased availability of the system. At the same time, the one-to-one correspondence between the generators and the variable speed motors due to the direct coupling allows preserving sufficiently high efficiency of the overall system, while maintaining a relatively small footprint of the system as well as a relatively small cost. Due to the above-mentioned

features, the disclosed system may be referred to as a "semi-direct variable speed drive with $N+1$ power availability."

Embodiment of claim 2 advantageously allows inclusion of one additional generator so that any one of the present
5 generators may be directly coupled to a fixed voltage and fixed frequency bus bar, the other N generators may be directly coupled to the N variable speed motors, while the remaining generator is either on stand by mode, or in maintenance, to be available for either the fixed frequency system or the variable
10 speed system. One or more of the variable speed motors may also be synchronized with the fixed voltage and fixed frequency bus bars to allow for load sharing and/or change of duty of the connected main driver/generator. Embodiment of claim 3 allows configuring the system to drive both variable and fixed speed
15 motors.

According to claim 4, each of the present generators may receive mechanical energy from a main driver. The main driver may be, for example, a gas turbine (claim 5) configured to convert thermal energy of a combustion gas into mechanical
20 energy. The gas turbine may comprise compressor(s) and combustion turbine(s), a steam turbine, or a gas or liquid fuel fired motor. Embodiments of claim 6 allow employing different kinds of variable speed motors.

Embodiment of claim 7 allows using the N variable speed
25 motors to drive mechanical rotating equipment, such as, for example, a compressor. In other embodiments, the systems of claims 1, 2, and 7 may altered to include multiple electric bus bar systems in lieu of the N variable speed motors and the mechanical rotating equipment.

30 Further, embodiment of claim 8 advantageously allows for a specific kind of the drive voltage to be provided to each of the N variable speed motors.

Embodiment of claim 9 allows having a dedicated stand-by generator for use when one of the other N generators cannot
35 operate.

Embodiment of claim 10 defines a particularly advantageous application of the system.

Embodiment of claim 11 enables control of the speed of the variable speed motors.

Embodiment of claim 12 advantageously enables a one-to-many relation.

A method for operating (parts of) the system is also disclosed.

Hereinafter, an embodiment of the invention will be described in further detail. It should be appreciated, however, that this embodiment may not be construed as limiting the scope of protection for the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic illustration of a direct coupling system for controlling speed of each variable speed motor according to prior art;

Figure 2 is a schematic illustration of an (N+1) availability system for controlling speed of each variable speed motor, according to one embodiment of the present invention;

Figure 3 is a schematic illustration of an (N+1) availability system for controlling speed of each variable speed motor, according to another embodiment of the present invention;

Figure 4 illustrates a duty and switching diagram corresponding to the system of Figure 3, according to one embodiment of the present invention;

Figure 5 is a schematic illustration of an (N+1) availability system for controlling speed of each variable speed motor, according to yet another embodiment of the present invention; and

Figure 6 illustrates a duty and switching diagram corresponding to the system of Figure 5, according to one embodiment of the present invention.

DETAILED DESCRIPTION

In the following description, numerous specific details are set forth to provide a more thorough understanding of the present invention. However, it will be apparent to one of skill in the art that the present invention may be practiced without one or more of these specific details. In other instances, well-known features have not been described in order to avoid obscuring the present invention.

Figure 2 is a schematic illustration of an (N+1) availability system 200 for controlling speed of each variable speed motor, according to one embodiment of the present invention. As shown, the system 200 includes four generators G1, G2, G3, and G4 configured to convert mechanical energy to electrical energy. In one embodiment, the generators G1-G4 may receive the mechanical energy from gas turbines, shown as GT1, GT2, GT3, and GT4 that are configured to convert thermal energy of the combustion gas to mechanical energy. In other
10 embodiments, the generators G1-G4 may receive mechanical energy from other fired engines (for example, steam turbine, gas motor or diesel motor operating on any fuel). Herein, the gas turbines (or steam turbines or other fired engines) providing mechanical energy to the generators are sometimes referred to as
15 "main drivers" in order to indicate that they represent the initial source of the energy provided to the variable speed motors.

The system 200 further includes three variable speed motors, shown as M1, M2, and M3, and a switching arrangement, shown as a switchboard 205, configured to directly couple, in a one-to-one relation, the generators G1-G4 to the variable speed motors M1-M3. Each of the variable speed motors M1-M3 is, in turn, connected to a piece of mechanical rotating equipment, for example, a compressor, shown in Figure 2 as CPR1, CPR2, and
25 CPR3. Alternatively, one or more of the variable speed motors M1-M3 may also be exchanged for one or more electrical distribution networks by introducing multiple bus bars systems in lieu of the motor and mechanical rotating equipment. The one or more variable speed motors M1-M3 may comprise one or more
30 electrical motors.

The generators G1-G4 are configured to drive each of the variable speed motors M1-M3 with a variable drive voltage. The drive voltage may be varied (modulated) in amplitude, frequency, or both amplitude and frequency, in order to achieve
35 the desired speed and torque for each of the variable speed motors M1-M3. Variable speed motors M1-M3 are driven by a 3-phase AC voltage. In turn, the variable speed motors M1, M2, and M3 are configured to convert the electrical energy of the variable drive voltage to the mechanical energy that drives the

compressors CPR1, CPR2, and CPR3. Thus, by modulating the drive voltage provided to the variable speed motors M1-M3 to control the speed and the torque of the motors M1-M3, the rotational speed of the compressors CPR1-CPR3 may be controlled as well.

5 As shown, the generator G4 is configured to be a dedicated stand-by generator. The switchboard 205 allows any of the variable speed motors M1-M3 to be driven by at least two of the generators G1-G4. In other words, each of the variable speed motors M1-M3 may be operated in at least two different
10 modes: in the first mode the variable speed motors M1, M2, and M3 are driven with drive voltages generated by the generators G1, G2, and G3, respectively, in a one-to-one relation between each of the variable speed motors M1-M3 and the generators G1-G3, and in the second mode each of the variable speed motors M1,
15 M2, and M3 is driven with drive voltages generated by the dedicated stand-by generator G4. For example, in the first mode all three motors can be started and subsequently be synchronized to form an electric power distribution network that will allow for load sharing. In the second mode the stand by generator G4
20 can be operated to allow for maintenance of any one of the main driver-generator combinations (i.e., the combinations of GT1-GT3 and G1-G3). With such a configuration, if, for example, the generator G2 is not operating (i.e., the generator G2 may be, for example, out of service due to failure or maintenance, or
25 may be in a stand by mode), all of the variable speed motors M1-M3 may still remain operating. In such a case, the variable speed motors M1 and M3 may be operated in the first mode (i.e., the variable speed motors M1 and M3 are driven by the generators G1 and G3, respectively), while the variable speed motor M2 may
30 be operated in the second mode (i.e, the variable speed motor M2 is driven by the stand-by generator G4).

Since in the system 200 four of the gas turbines GT1-GT4 are configured to drive three variable speed motors M1-M3, the system 200 is operated by having one redundant gas turbine-generator combination which may be used to provide electrical
35 power when one of the other three gas turbine-generator combinations fail. Such a configuration is referred to herein as having (N+1) availability, where the term "availability" refers to the ability of the power consumers (e.g., the variable speed

motors M1-M3 or the compressors CPR1-CPR3) to obtain the desired electrical power. If a power consumer cannot obtain the desired power, the power consumer is said to be "unavailable." Having the (N+1) configuration in the system 200 results in greater
5 availability of the system 200 when compared to, for example, the system 100.

Note that the operational envelope of the dedicated stand-by generator G4 is limited as the stand-by generator G4 should be brought back to the stand-by mode as soon as possible
10 in order to be able to stand-by again for the other generators. Thus, the system 200 does not have the option to share load equally over time (for example, wear and tear of the generators G1-G4).

Figure 3 is a schematic illustration of an (N+1)
15 availability system 300 for controlling speed of each variable speed motor, according to another embodiment of the present invention. As shown, the system 300 also includes four generators G1-G4 configured to convert mechanical energy to electrical energy. Again, the generators G1-G4 may receive the
20 mechanical energy from gas turbines GT1-GT4 or from other types of main drivers.

Similar to the system 200, the system 300 further includes three variable speed motors M1-M3, and a switching arrangement, shown as a switchboard 305, configured to directly
25 couple, in a one-to-one relation, the generators G1-G4 to the variable speed motors M1-M3. Each of the variable speed motors M1-M3 is, in turn, connected to a piece of mechanical rotating equipment, for example, a compressor, shown as CPR1, CPR2, and CPR3. The one or more variable speed motors M1-M3 may comprise
30 one or more electrical motors. Again, the generators G1-G4 are configured to drive each of the variable speed motors M1-M3 with a variable drive voltage. The drive voltage may be varied (modulated) in amplitude, frequency, or both amplitude and frequency, in order to achieve the desired speed for each of the
35 variable speed motors M1-M3. Variable speed motors M1-M3 are driven by a 3-phase AC voltage. In turn, the variable speed motors M1, M2, and M3 are configured to convert the electrical energy of the variable drive voltage to the mechanical energy that drives the compressors CPR1, CPR2, and CPR3. Thus, by

modulating the drive voltage provided to the variable speed motors M1-M3 to control the speed and the torque of the motors M1-M3, the rotational speed of the compressors CPR1-CPR3 may be controlled as well. Alternatively, one or more of the motors can
 5 also be exchanged for one or more electrical distribution networks by introducing multiple bus bars systems in lieu of the motor and rotating equipment.

By using switches, the switchboard 305 allows any of the variable speed motors M1-M3 to be driven by at least two of
 10 the generators G1-G4 within specific dedicated combinations (an example of a set of dedicated combinations is described below). In other words, each of the variable speed motors M1-M3 may be operated in at least two different modes: in the first mode the variable speed motor M1, M2, or M3 is driven with a drive
 15 voltage generated by one of the generators G1-G4, and in the second mode the variable speed motor M1, M2, or M3 is driven with a drive voltage generated by another one of the generators G1-G4. For example, the switchboard 305 may include switches S1 and S2 as shown on Figure 3. The switches S1 and S2 allow the
 20 following dedicated combinations: the variable speed motor M1 may be driven, in the first mode, by the generator G1 and, in the second mode, by the generator G2; the variable speed motor M2 may be driven, in the first mode, by the generator G2 and, in the second mode, by the generator G3; finally, the
 25 variable speed motor M3 may be driven, in the first mode, by the generator G3 and, in the second mode, by the generator G4. With such a configuration, if, for example, the generator G2 is not operating (i.e., the generator G2 may be, for example, out of service due to failure or maintenance, or may be in a stand by
 30 mode), all of the variable speed motors M1-M3 may still remain operating. In such a case, the variable speed motor M1 may be operated in the first mode (i.e., the variable speed motor M1 is driven by the generator G1), the variable speed motor M2 may be operated in the second mode (i.e., the variable speed motor M2 is
 35 driven by the generator G3), and the variable speed motor M3 may also be operated in the second mode (i.e., the variable speed motor M3 is driven by the generator G4).

Person skilled in the art will recognize that operating switches will require coordination of voltage and phase angle to

allow synchronization of two isolated electrical systems. Furthermore, in other embodiments, instead of the switches S1 and S2 shown in Figure 3, the switchboard 305 may include any other switching arrangement configured to directly couple, in a one-to-one relation, the variable speed motors M1-M3 to the generators G1-G4 so that any one of the variable speed motors M1-M3 is capable of operating in at least a first mode and a second mode described above.

Figure 4 illustrates a duty and switching diagram corresponding to the system 300. As shown in Figure 4, when the switching arrangement includes switches S1 and S2 as shown in the system 300 of Figure 3, four combinations are possible. In the first combination, the generator G4 is not operating. By closing the switch S2, the generator G1 may be configured to drive the variable speed motor M1, the generator G2 may be configured to drive the variable speed motor M2, and the generator G3 may be configured to drive the variable speed motor M3. In the second combination, the generator G3 is not operating. By keeping both of the switches S1 and S2 open, the generators G1, G2, and G4 may be configured to drive the variable speed motors M1, M2, and M3, respectively. The other two combinations may be analyzed in a similar manner.

The (N+1) availability of the generators G1-G4 within the system 300 leads to an increased availability of the system 300 relative to that of the system 100 illustrated in Figure 1 because even if one of the generators G1-G4 is not operating, the three variable speed motors M1-M3 may be driven by the remaining three generators. The permanent one-to-one relation between the gas turbines GT1-GT4 and the mechanical rotating equipment CPR1-CPR3 is decoupled in the system 300, allowing for continuous speed control of the mechanical rotating equipment with redundancy in the main driver-generator combination. At the same time, the direct coupling between the generators G1-G4 and the variable speed motors M1-M3 allows maintaining the overall efficiency of the system 300 substantially equal to the efficiency of system 200. The system 300 has a number of further advantages for applications that require a small footprint of the mechanical rotating equipment and physical separation between the main driver and the mechanical rotating

equipment (for example, for off-shore applications). The compressors CPR1, CPR2, and CPR3 included in the system 300 have a smaller footprint than the compressors included in the system 100 because the electric variable speed motors M1-M3 are much smaller than the gas turbines of Figure 1 or any other main driver such as steam turbine or fired engine. Second, the system 300 allows the gas turbines GT1-GT4 or any other main drivers to be located away from the processes that the compressors CPR1-CPR4 are involved in (such as, for example, liquefaction of gas), leading to an improved safety because of removal of hot surfaces from the process area and by not introducing fuel in the process area. Third, the system 300 allows the gas turbines GT1-GT4 or any other main drivers to be located at a place where maintenance may be organized best. Also, if waste heat of the exhaust gases is to be utilized elsewhere on the plant the affiliated equipment can now be located at one location thus enhancing the simplicity of the overall layout. The one-to-one relation between main driver-generator combination and mechanical rotating equipment may eliminate the requirement of having a gearbox between electric motor and mechanical rotating equipment.

In addition, if variable speed is only required during start-up or controlled stopping of the mechanical rotating equipment, the normal steady state operation may also be with N generators and N motors coupled via the switchboard 305, thus enabling load sharing between the active main drivers and generators all running at the same speed. This circuitry and operation differs, because of the maintainable one-to-one relation, from configurations presently found in the industry where multiple main driver and generators are combined on a single bus bar driving multiple motors at equal variable speed.

Figure 5 is a schematic illustration of an (N+1) availability system 500 for controlling speed of each variable speed motor, according to yet another embodiment of the present invention. As shown, the system 500 includes five generators G1, G2, G3, G4, and G5 configured to convert mechanical energy to electrical energy. Again, the generators G1-G5 may receive the mechanical energy from gas turbines (shown as GT1, GT2, GT3, GT4, and GT5) or from steam turbines or other fired engines.

The system 500 further includes three variable speed motors (shown as M1, M2, and M3), each possibly including one or more electrical motors, two fixed speed motors (shown as M4 and M5), and a switching arrangement (shown as a switchboard 505),
5 configured to directly couple, in a one-to-one relation, four of the generators G1-G5 to the variable speed motors M1-M3 and to directly couple (at least one of) the remaining of the generators G1-G5 to a fixed voltage and fixed frequency bus bar 510. As used herein, the term "bus bar" refers to a strip of
10 conductive material (such as, for example copper or aluminium) that conducts electricity within a switchboard or other electrical apparatus. Each of the variable speed motors M1-M3 is, in turn, connected to a piece of mechanical rotating equipment, for example, a compressor, shown as CPR1, CPR2, and
15 CPR3.

Similar to Figure 3, four of the generators G1-G5 are configured to drive each of the variable speed motors M1-M3 with a variable drive voltage. Again, the drive voltage may be varied (modulated) in amplitude, frequency, or both amplitude
20 and frequency, in order to achieve the desired speed of each of the variable speed motors M1-M3. Variable speed motors M1-M3 are driven by a 3-phase AC voltage. In turn, the variable speed motors M1, M2, and M3 are configured to convert the electrical energy of the variable drive voltage to the mechanical energy
25 that drives the compressors CPR1, CPR2, and CPR3. Thus, by modulating the drive voltage provided to the variable speed motors M1-M3 to control the speed and the torque of the motors M1-M3, the rotational speed of the compressors CPR1-CPR3 may be controlled. If variable speed is only required during start-up
30 or controlled stopping of the machinery, the normal steady state operation may also be with N+1 generators and N motors combined on bus bars 510, 520 and 530 at a fixed voltage and a fixed frequency thus enabling load sharing between the active main drivers and generators. Alternatively, one or more of the
35 motors can also be exchanged for one or more electrical distribution networks by introducing multiple bus bars systems in lieu of the motor and mechanical rotating equipment.

By using switches, the switchboard 505 allows any of the variable speed motors M1-M3 to be driven by at least two of

the generators G1-G5. For example, the switchboard 505 may include switches S1, S2, S3, and S4 as shown on Figure 5. The switches S1-S4 allow the variable speed motor M1 to be driven, in the first mode, by the generator G1, in the second mode, by the generator G2, and, in the third mode, by the generator G3. Similarly, the switches S1-S4 allow the variable speed motor M2 to be driven, in the first mode, by the generator G2, in the second mode, by the generator G3, and, in the third mode, by the generator G4. Finally, the variable speed motor M3 may be driven, in the first mode, by the generator G1, in the second mode, by the generator G4, and, in the third mode, by the generator G5. With such a configuration, if, for example, the generator G2 is out of service and the generator G5 is providing fixed voltage to the fixed voltage and fixed frequency bus bar 510, all of the variable speed motors M1-M3 may still remain operating. In such a case, the variable speed motor M1 may be operated in the third mode (i.e., the variable speed motor M1 is driven by the generator G3), the variable speed motor M2 may also be operated in the third mode (i.e., the variable speed motor M2 is driven by the generator G4), and the variable speed motor M3 may be operated in the first mode (i.e., the variable speed motor M3 is driven by the generator G1).

Figure 6 illustrates a duty and switching diagram corresponding to the system 500. As shown in Figure 6, when the switching arrangement includes switches S1-S4 as shown in the system 500 of Figure 5, twenty one combinations are possible. In the first combination, the generator G4 is not operating (i.e., the generator G4 may be, for example, out of service due to failure or maintenance, or may be in a stand by mode) and the generator G5 is providing fixed voltage to the fixed voltage and fixed frequency bus bar 510. In this case, the generator G1 may be configured to drive the variable speed motor M3, the generator G2 may be configured to drive the variable speed motor M1, and the generator G3 may be configured to drive the variable speed motor M2, while all of the switches S1-S4 remain open. In the second combination, the generator G5 is not operating and the generator G4 is providing fixed voltage to the fixed voltage and fixed frequency bus bar 510. In this case, the generators G2, G3, and G1 may be configured to drive the variable speed

motors M1, M2, and M3, respectively, as in the first combination. In the third combination, the generator G3 is not operating and the generator G5 is providing fixed voltage to the fixed voltage and fixed frequency bus bar 510. In this case, the generator G1 may be configured to drive the variable speed motor M3, the generator G2 may be configured to drive the variable speed motor M1, and the generator G4 may be configured to drive the variable speed motor M2, while all of the switches S1-S4 remain open. The other combinations may be analyzed in a similar manner.

In this manner, the (N+1) power availability may be provided for the variable speed motors M1-M3 as well as for the fixed voltage and fixed frequency power consumers, such as, for example, the fixed speed motors M4 and M5. In general, in a system including N variable speed motors and N+K generators, where N is an integer equal to or greater than 1 and K is an integer equal to or greater than 2, the N variable speed motors may be directly coupled to (N+1) generators, while the remaining (K-1) generators may be connected to a fixed voltage and fixed frequency bus bar (with one of the generators being in stand by mode or in maintenance). If variable speed is only required during start-up or controlled stopping of the machinery, the normal steady state operation may also be with N+1 generators and N motors combined on bus bars 510, 520 and 530 thus enabling load sharing between the active main drivers and generators.

Persons skilled in the art will recognize that while Figures 2, 3, and 5 illustrate the generators receiving mechanical energy from gas turbines, in other embodiments the generators may also receive mechanical energy from other fired engine, such as, for example, steam turbine, gas motor or diesel motor operating on any fuel. Furthermore, while Figures 2, 3, and 5 illustrate compressors being connected to the variable speed motors, in other embodiments, other types of mechanical rotating equipment may be used, such as, for example, pumps, fans, blowers and ship's propulsion. In addition, any of the variable speed motors M1-M3 and any of the fixed speed motors M4 and m5 illustrated in Figures 2, 3, and 5, may comprise one or more motors.

One advantage of the present invention is that increased reliability of the system may be realized by operating the generators at $(N+1)$ availability. At the same time, the one-to-one correspondence between the generators and the variable speed motors due to the direct coupling allows preserving speed and torque control and sufficiently high efficiency of the overall system over any electronic speed control unit, while maintaining a relatively small footprint of the variable speed motor as well as a relatively small cost to obtain $(N+1)$ availability. In addition, because of the absence of switching electronics, no harmonic distortion is introduced to the fixed voltage and fixed frequency consumers. The electric power generation equipment will not be installed in the area where the rotating equipment will be located, i.e. process modules. This is especially relevant for offshore applications where safety and maintainability are predominant aspects governing the equipment arrangement.

While the forgoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof. For example, aspects of the present invention may be implemented in hardware or software or in a combination of hardware and software. Therefore, the scope of the present invention is determined by the claims that follow.

CLAIMS

1. A system for controlling a speed of each of N variable speed motors with a drive voltage, where N is an integer equal to or greater than 1, comprising:

(N+1) generators configured to drive the N variable speed motors; and

a switching arrangement configured to directly couple, in a one-to-one relation, the N variable speed motors to present generators so that any one of the N variable speed motors is capable of operating in at least a first mode and a second mode,

wherein:

the present generators comprise the (N+1) generators,
in the first mode the any one of the N variable speed motors is driven with the drive voltage generated by a first generator of at least two of the present generators, and
in the second mode the any one of the N variable speed motors is driven with the drive voltage generated by a second generator of the at least two of the present generators.

2. The system of claim 1, further comprising an additional generator, wherein:

the present generators further comprise the additional generator,

the switching arrangement further includes a fixed voltage and fixed frequency bus bar, and

the switching arrangement is further configured to directly couple one of the present generators to the fixed voltage and fixed frequency bus bar.

3. The system of claim 2, wherein one or more fixed speed motors are connected to the fixed voltage and fixed frequency bus bar.

4. The system of claims 1 or 2, wherein each of the present generators is connected to a main driver.

5. The system of claim 4, wherein the main driver comprises a gas turbine.

6. The system of claims 1 or 2, wherein the N variable speed
5 motors comprise at least one of an electric induction motor or a synchronous motor.

7. The system of claims 1 or 2, wherein each of the N variable
10 speed motors is configured to drive mechanical rotating equipment.

8. The system of claims 1 or 2, wherein the drive voltage is a single-phase voltage.

9. The system of claims 1 or 2, wherein the first generator or
15 the second generator comprises a dedicated stand-by generator.

10. The system of claims 1 or 2, wherein the system comprises an
20 off-shore power system.

11. The system according to claims 1 or 2, wherein the drive
voltage is a 3-phase AC voltage.

12. The system according to claims 1 or 2, wherein each of the N
25 variable speed motors comprises one or more electrical motors.

13. A method for controlling a speed of each of N variable speed
motors with a drive voltage, where N is an integer equal to or
greater than 1, in a system comprising:

30 (N+1) generators configured to drive the N variable
speed motors; and

a switching arrangement configured to directly couple,
in a one-to-one relation, the N variable speed motors to present
generators so that any one of the N variable speed motors is
35 capable of operating in at least a first mode and a second mode,
and wherein the present generators comprise the (N+1)
generators, the method comprising:

in the first mode, driving the any one of the N variable speed motors with the drive voltage generated by a first generator of at least two of the present generators, and

5 in the second mode, driving the any one of the N variable speed motors with the drive voltage generated by a second generator of the at least two of the present generators.

10 14. The method of claim 11, further comprising steps for operating the system according to claims 2-13.