

Introduction

Utilising the vast energy resources of the wind for power generation has now for years been regarded as a feasible and environmental friendly technology. Today, policy makers and power supplying utilities around the world consider wind energy connected to the major, large grids as a viable and technical mature concept.

The potential for wind energy connected to small or isolated grids is likewise enormous, but until recently power production from wind energy, fed into small and isolated grids, have been economically unattractive due to inefficiency and technical problems with the necessary diesel generation back up system. Normally when a diesel engine operates at less than 30% of its load capacity, the diesel engine will have a bad fuel economy and will be choking thus reducing the efficiency of the engine and causing its deterioration.

Recently, technical developments have solved these problems, and with these developments it is now possible to operate wind-diesel system up to 100% wind penetration. With this development, remote areas and island are offered the opportunity to utilize wind energy in combination with diesel generated power for their power production. Such a viable wind/diesel (WD) stand-alone system will be able to operate with an estimated 50% to 80% fuel saving compared to power supply from diesel generation alone.

Power production, which is fed into isolated grids, diverges considerably from production fed into major grids considering the economically, technically and environmentally conditions:

Economically

Typically, the power fed into small, isolated grids is generated by means of combustion engines (diesel generator sets), and cost of power production by diesel generation is relatively high. Compared to the relative power cost (price per kWh energy) from a conventional power plant supplying to major grids, the price of power produced by diesel generators is often seen to be considerably higher - especially when taking the constantly increasing diesel oil prices and the related transportation costs into consideration.

Technically

The power output from wind turbines varies during the day according to the variations in wind speed. When wind turbines are connected to a major grid these variations and fluctuations in wind power are absorbed by the strong grid, thus controlling frequency and voltage. At small and isolated grids the power balance between production and consumption has to be continuously maintained in order to keep frequency and voltage of the small grid within predefined limits.

Environmentally

Normally, power generating plants feeding into small, isolated grids consist of several small generating units with a relatively low efficiency and poor combustion of the fuel. Furthermore, the environment in such areas is more sensitive to pollution from exhausts gases (CO₂, SO₂ and NO_x) and other waste, as well as noise emissions and visual impact on the surroundings.

In order to be able to operate wind power together with diesel generators for small, isolated grids, Vestesen A/S can offer the unique Danvest WD concept. This concept has with due consideration to the above three aspects been developed in order to allow wind energy to substitute a considerable part of the diesel power production with full control of the power quantity and quality.

Danvest wind/diesel concept

Production of power by means of wind turbines is a well known technology and with the newest types of wind turbines the power quality has been improved. However, until now the limitation has been that it is necessary to control the wind turbines via the major grid, and this has normally limited the contribution from wind energy into major grids to 20-30% of the total power demand.

For small, isolated grids Danvest has solved the problem of controlling the quantity and quality of wind energy, whereby the power supply from the wind energy can be increased to 100% of the demand and thereby during periods of high wind substitute the diesel power completely.

Danvest has for the WD concept developed a unique controlling system for the WD hybrid power production, which replaces the normal controlling function of the major grids.

The system can be based on normal diesel generator sets fitted with the patented WD equipment for backing up the wind turbines when they are supplying from 0 to 100% of the power consumption, and the WD system controls automatically the continuous operation:

- When the wind energy is sufficient to supply all consumption, the diesel engine is clutched out and stopped. The alternator remains connected to the bus bar for controlling (dump load controlling) of:
 - Reactive power
 - Voltage
 - Frequency
- When the wind speed is decreasing / consumption is increasing the diesel engine is started and clutches in automatically within 1-3 seconds.
- The dump load controlling is securing a fast dynamic load balance between the fluctuating wind power and the variations in consumption. A stable Voltage and Frequency of 50/60 Hz \pm 0.1-0.3 Hz is obtained and the resulting fluctuations are negligible
- The diesel engines that are fitted with the WD equipment are able to operate at low load for longer periods, thus maintaining normal service intervals.

With the Danvest WD concept an annual fuel saving up to 50-80% is obtained, depending on the actual wind conditions and the size of the wind turbines, and this saving is more than covering the additional costs related to the wind turbines and the WD equipment.

The energy absorbed by the main cooling system for the diesel generating sets and dump-load can furthermore be utilized for seawater desalination (distillation) or central heating, whereby the efficiency of the system can be further increased.

As further options to the Danvest wind/diesel concept the following systems can be added:

- Reverse Osmosis process for desalination of seawater. The power for the desalination process can be supplied from the wind / diesel system mainly as excess power from the wind energy production when this exceeds the normal consumption. This means that the drinking water production will mainly be based on environmental friendly energy.
- Flake ice / ice bank systems for the food industry. Often there is a demand in the remote areas, which are suitable for the WD system, for cooling of fishing and agricultural products, and this can be covered based on power produced in an environmental friendly way.

Design Concept

The Danvest WD system is a complete, modular concept where the components are interdependent. The system has a high degree of flexibility and can be adjusted according to the project specific demands.

Depending on specific local conditions, the required inputs may vary i.e. it may be that already installed (diesel) capacity is available to some extent. Such existing capacity can be overhauled or renovated thereby constituting one component of the complete system. In these cases only parts of the complete system will be supplied.

The Danvest WD system can be delivered as a pre-fabricated and containerized system, where all components are delivered in standard 20' or 40' containers. This facilitates easy transport, fast and uncomplicated installation, and furthermore the lay-out can be prepared for future extensions.

All components, panels, enclosures and cables are of materials with a degree of protection suitable for the climatic and electrical conditions to which they will be exposed. The design will comply with applicable standards and regulations.

Operation and Control

The main operation principle is that the Danvest WD system is able to supply power according to the actual consumption based on an optimized utilization of the actual wind power production. This is a fully automated operation.

The control system integrating the diesel and wind power systems is integrated into the control system of the power station and located in the power panels.

A central monitoring computer based system with a comprehensive data acquisition capacity for reporting the operation data as basis for reporting analysis of the performance of the system is located at the diesel power station. This allows the operators on site to overview the total WD system, and outside normal operating hours an alarm system for calling the operator can be added.

The control system is connected to the public ISDN network or a satellite link, which enables remote monitoring and control of the Danvest WD system. The remote monitoring and control can e.g. be from a main central power station being in control of several power stations.

Training

Training of the staff being responsible for daily operation forms an essential part of the success of a sustainable project.

Vestesen A/S offers a complete training program in order to enable the staff to operate and maintain the complete system with a high degree of efficiency and reliability. Furthermore the training will enable the staff to conduct various minor repair works when needed.

It is recommended that the management also will participate in part of the training program related to the general management and functions of the system. This will ease the understanding and cooperation between the daily operating staff and the management and secure the back-up assistance needed from time to time.