

Danvest Power Unit for Wind Diesel Power Stations

Function & Performance Tests of Unit Installed with Desalination Plant

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Transcript from the report : " Summary".

Summary

Introduction

It is estimated that approx. 150,000 local communities world wide have their power supplied from diesel generators. In many of these places potable water is also a scarce commodity, and systems that integrate desalination plants and wind turbines may potentially produce both water and electricity at lower rates.

Danvest Energy has developed a Diesel Power Unit which may be coupled to standard grid connected wind turbines to make up a complete wind diesel system in which waste and surplus energy is utilized for e.g. fresh water production. The Danvest Power Unit has a simple and robust plant lay-out suitable for remote applications, and it includes precautions for improving diesel conditions at low load and the possibility of stopping the diesel engine completely when there is enough wind power.

A pilot plant that includes a 500 kW diesel genset and a 16m³/24h desalination unit, has been installed for demonstration purposes in Denmark in connection with an existing 880kW wind farm. The purpose of this report is to document function, performance and stability based on measurements made during 1994-1995.

Background

In a wind diesel system a significant amount of wind power is integrated in the diesel power system. Although the operation of the diesel units are influenced by the wind power the main requirements of such systems are the same as for diesel-only systems: To supply firm and reliable power of good quality.

The main feature of a wind diesel system is the amount of saved fuel compared to the extra investment in wind turbines and control system. Other important features include easy installation, operation and maintenance, and the use of standard components. Also, integrated fresh water production is often a desirable feature.

Surplus wind energy occurs when some of the wind power has to be dumped in order to maintain minimum diesel load. Using such excess power for e.g. water desalination may increase the profitable amount of wind power capacity that can be installed.

The Danvest Power Unit Concept

The main components of the Power Unit are a diesel genset, a specially designed cooling circuit and a control system. Waste heat from the engine and surplus wind power can be used for purposes such as fresh water production. The unit can be enclosed in 20' or 40' container modules, and it is designed for use in combination with standard wind turbines. No energy storage is included or needed.

Power quality even with a high degree of wind energy penetration is ensured by the standard controllers coming with the Danvest Power Unit. The diesel engine may be stopped during periods with sufficient wind power in order to increase the fuel saving, and it can operate at low loads for long periods through the use of a patented low load unit.

In the Danvest Power Unit any surplus wind energy is dissipated in a preheater/dump load embedded in the cooling circuit where also the cooling system of the diesel and an exhaust heat exchanger is included. In the pilot plant energy is extracted from the circuit by a distiller (MED) producing fresh water. This concept makes it possible to utilize waste heat from the diesel engine and the fast fluctuating surplus wind power in a relatively simple and robust way.

The demonstration system in Ebeltoft

The system at Ebeltoft is built using standard components from several suppliers as listed in the main report. The control system is implemented on standard hardware. The Danvest Power Unit is contained in two containers with a machine hall between them.

The specifications of the main components in the Ebeltoft system are listed in the main report and they include a 526 kWe Perkins-Dorman-Leroy Somer diesel generator and an 18t/24h Alfa Laval desalination unit. The wind farm consists of 16 Nordtank 55 kW wind turbines dispersed over a substantial length of access road and pier.

When connected to the wind farm the wind diesel system is entirely autonomous and it controls voltage and frequency by its own controllers. The temperature of the cooling circuit reflects the level of excess (electric and heat) energy, and the distiller produces water accordingly.

The measurement system is based on a standard industrial datalogging system from IPH Automation. The system measures the power balance and temperatures of the system as well as several other parameters.

Results

The measurements aim at documenting the function and operation of the system as specified by Danvest Energy. This has been done in shorter campaigns under supervision of one or more persons from Danvest, Risø or Darup Associates, and in longer sessions monitored by the measurement system.

The system has been tested with the diesel both stopped and running as well as during diesel start and stops. In all situations the voltage and frequency are controlled and stable within acceptable levels, and the diesel generator responds swiftly to changes in loads or wind power. The controllers maintain proper power balance in the system even under significant load and wind power fluctuations.

The operation of the system at different levels of wind energy has been measured. Any excess wind power is dissipated in the preheater/dump load and the power in the cooling circuit is increased. The power available for e.g. fresh water production has a minimum when the wind power production equals the consumer load.

In the pilot plant the criteria for start and stop of the diesel engine work well for all reasonable changes in load or wind power. The pilot plant is connected to 16 x 55 kw wind turbines therefore the output from the wind farm in this case is more stable than in most other cases.

The structure of the criteria seems well suited to the task. The values of the parameters of the start and stop criteria will have to be adjusted to the conditions at each specific site. This will influence the amount of diesel fuelled power that has to be dumped, and consequently the amount of wind energy that may profitably be installed.

The operation of the system is as intended, also at low load on the diesel where there are no signs of instability. The fuel consumption at low load of the diesel is very low due to the low load unit. The actual performance in terms of saved fuel and available excess heat for a given system is very dependent of the wind resources and the load demand at the site.

Conclusions

The Power Unit developed by Danvest Energy is well suited for simple and robust wind diesel systems. The function and performance tests show that the Power Unit at Ebeltoft Ferry Harbour operates as intended.

The system is stable and the control system operates the start and stop of the diesel as specified. The diesel start/stop logic is very general and can be adapted to different operating conditions.

The cooling circuit, which is part of the Danvest Power Unit concept, handles the waste heat from the diesel engine and the surplus wind power as intended and makes it available for e.g. seawater desalination.

The fuel consumption when the load of the diesel is low (5-8%) is very low due to the low load unit.

A measurement report on the voltage and frequency stability made by Elsamprojekt A/S is included in Appendix C.