

Diesel Dispatch Strategies in High Penetration Wind-Diesel Power Systems

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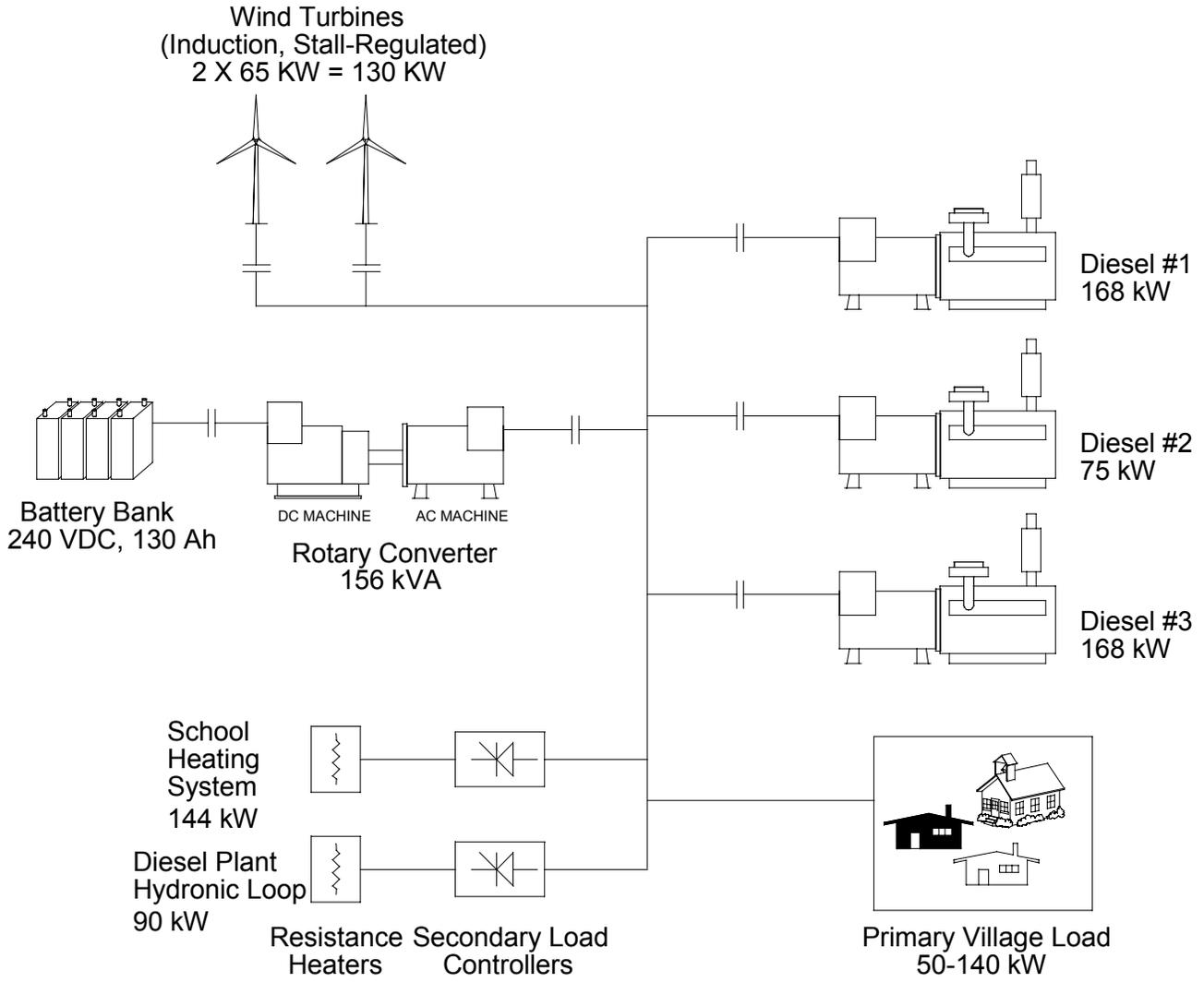
Sustainable Automation, LLC



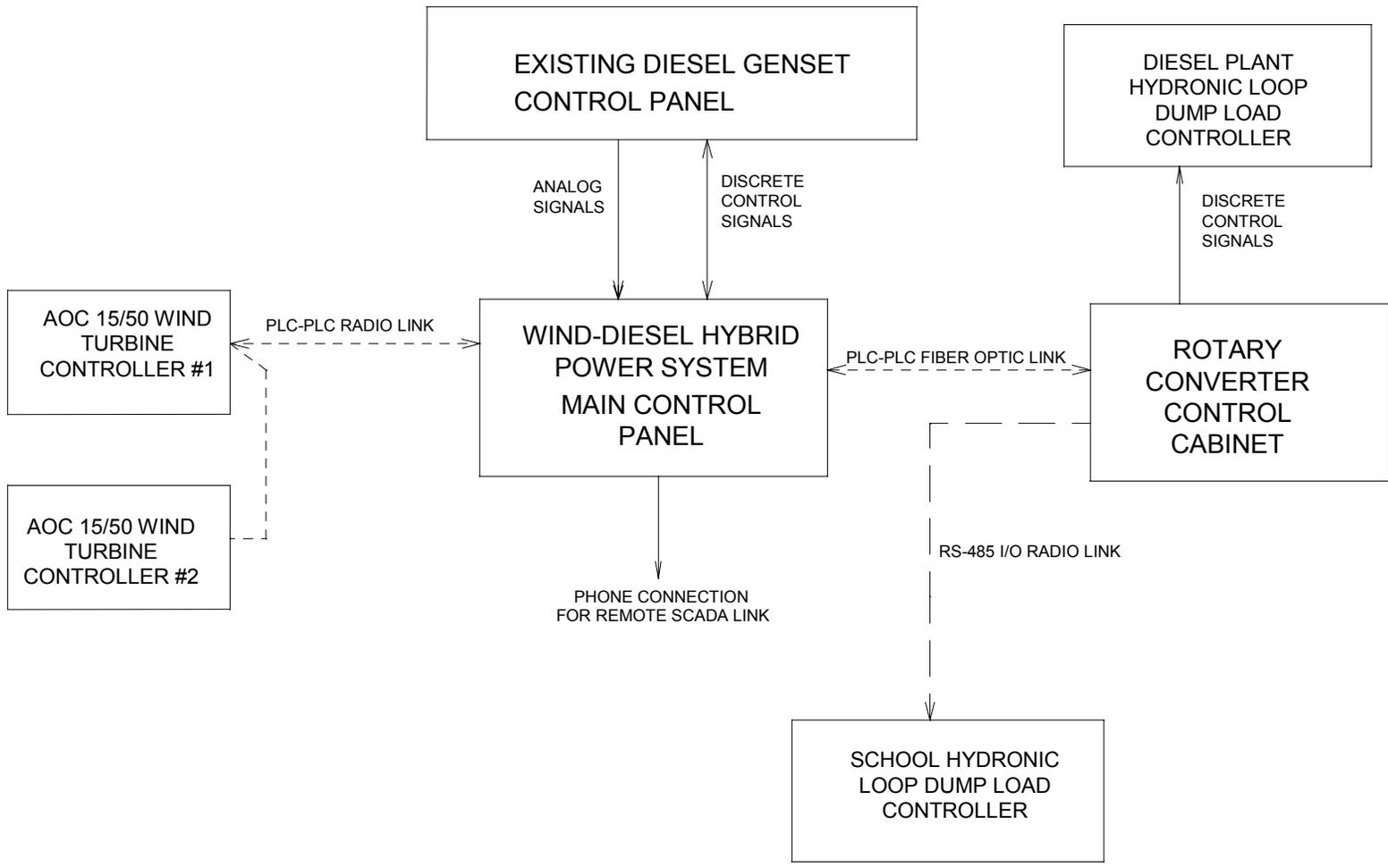
Village of Wales, Alaska



Wales Wind-Diesel System Architecture



Wales Wind-Diesel System Communication and Control



System Controller Tasks

- Component Dispatch
- Component Control
- Energy Storage Management
- Alarm Handling
- Operator Interface



Diesel Dispatch vs. Diesel Control

- Diesel Dispatch

- The process of determining diesel generating capacity required to be on-line at any given moment

- Diesel Control

- The process of turning on/off actual control signals in order to start/stop, synchronize, and load/unload a generator



Objective of Diesel Dispatch

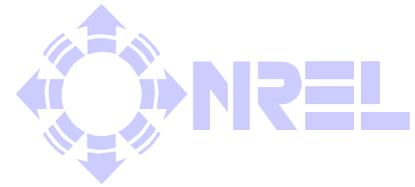


To determine the minimum amount of diesel capacity that must be on-line to ensure that the primary load is always met (“diesel capacity *required*”)

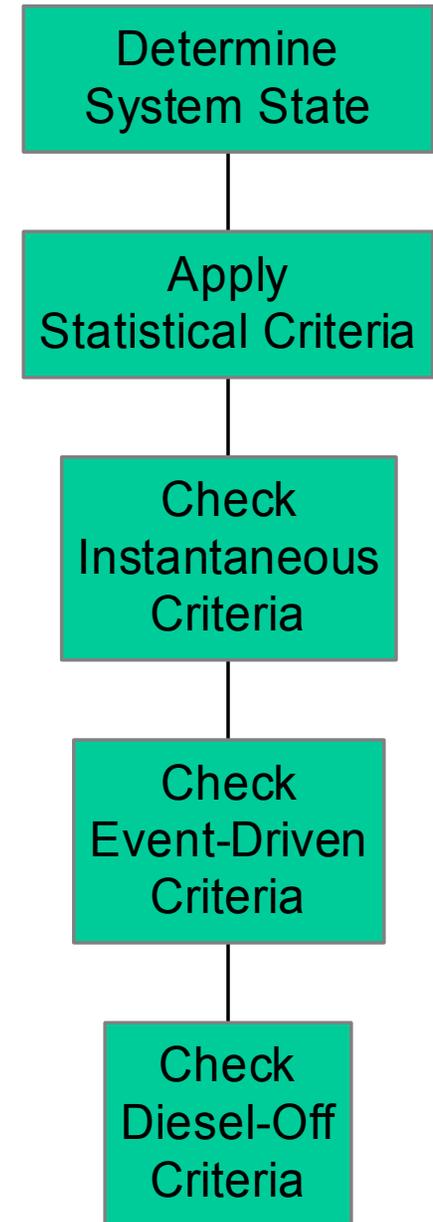
Complications:

- Load and wind power fluctuations
- Diesel capacity cannot be added instantaneously





Diesel Dispatch Flow Chart



System State

- Definition

- The combination of power sources on-line at any given moment

- Significance with respect to Diesel Dispatch

- Diesel generators must supply any part of the primary load greater than what can be supplied by the combination of other power sources on the bus



Statistical Dispatch Criteria: Basic Concepts

- Serves as the foundation of Diesel Dispatch
- Objective
 - Predict the maximum load which must be met by the diesels in the near future
- Method
 - Apply algorithms based on the current state and recent statistical values of wind power and load
 - Average power values
 - Maximum and minimum power values



Statistical Dispatch Criteria: Peak Load Algorithms

Any State without Batteries :

Diesel Capacity Required =

Primary Load 10m Peak - WTG Power 10m Minimum

Any State with Batteries :

Diesel Capacity Required =

Primary Load 10m Peak - WTG Power 10m Minimum

- Rotary Converter Power Limit

Various safety factors not shown.



Statistical Dispatch Criteria: Average Load Algorithm



Any State :

$$\text{Diesel Capacity Required} = \frac{\text{Primary Load 10m Average} - \text{WTG Power 10m Average}}{\text{Maximum Allowed Continuous \% Diesel Loading}}$$



Instantaneous Dispatch Criteria: Basic Concepts



- Objective

- Backup statistical predictions with checks to detect higher than anticipated loads

- Method

- Monitor instantaneous power values and dispatch additional diesel capacity should they exceed specified limits



Instantaneous Dispatch Criteria: Example Algorithm



Any State with Diesel(s) but without Batteries :

$$\frac{\textit{Diesel Capacity Required} = \textit{Diesel Load} - \textit{Secondary Load}}{\textit{Maximum Allowed Instantaneous \% Diesel Loading}}$$



Event-Driven Dispatch



Criteria:

Basic Concepts

- Objective

- Prepare for imminent changes to system state which necessitate greater diesel capacity than would be estimated by load-based criteria and current state

- Method

- Determine what the diesel capacity required would be if the change had already taken place and dispatching diesel capacity accordingly beforehand



Event-Driven Dispatch

Criteria:

Examples of Component Special Conditions



- Wind turbine ready to start
- Imminent loss of a system component
 - Component Warnings
 - Wind Turbine Nearing High Wind Shutdown
 - Low Battery State of Charge
 - Secondary Load Maximum Temp Reached
 - Operator request to disable component



Diesel-Off Criteria: Basic Concepts

- Objective

- Ensure that all requirements, in addition to Diesel Capacity Required being less than zero, are met before all diesels are allowed to be shut off

- Example of Additional Requirement

- Require sufficient excess wind power to keep the diesel engines warm and to heat the power plant

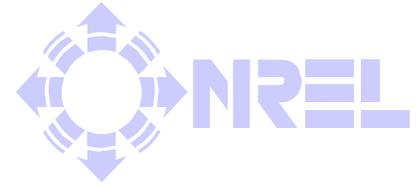


Diesel-Off Criteria: Example Algorithm

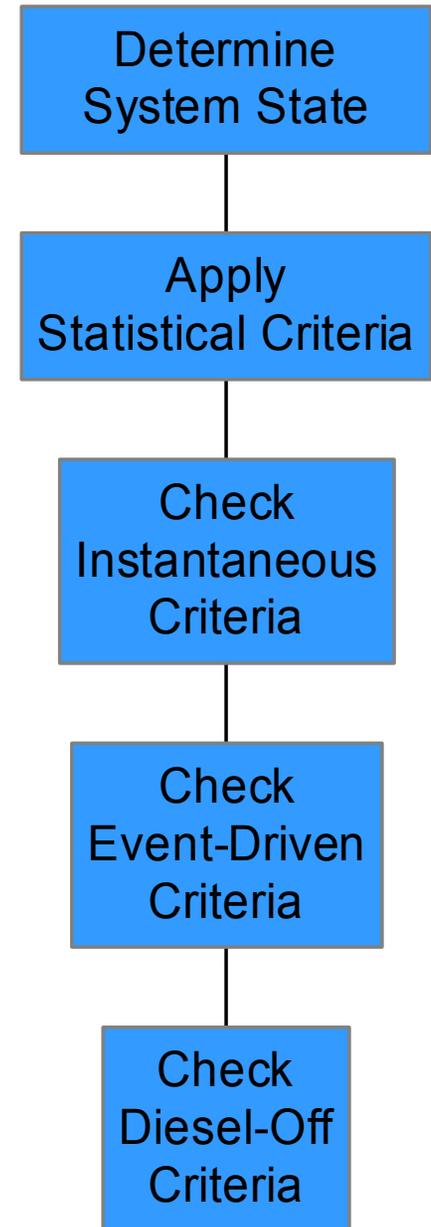


Diesel Off Operation Not Allowed Unless :
WTG Power 10m Avg - Primary Load 10m Avg
> Plant Heat Required





Summary



Questions?

