Wind-Diesel Technology

Getting It Right

2008 International Wind-Diesel Workshop

April 23-25, 2008

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Ramea Wind-Diesel Project

Ramea, NL

Points for Discussion

- Frontier Power Systems Inc
  - Who we are; What we do
- Ramea
  - Genesis
  - Description of Ramea wind-diesel project
  - What we learned
  - Where we're going

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Frontier Power Systems Inc.

- Formed in 2003 to commercialize AWTS wind-diesel technology
- Currently Two Areas of Focus
  - Utility Wind Consultants **$$$**
  - Wind-Diesel Systems Integrators ♥ ♥ ♥
- Long Engineering Experience
  - 25 years in wind energy
  - > 20 years in wind-diesel
- Significant Projects Completed
  - AWTS – 20 years
  - Ramea Wind-Diesel Project
  - North Cape Wind Plant (10.5 MW Wind plant in PEI)
  - East Point Wind Plant (30 MW Wind plant in PEI)
  - PEI Wind Hydrogen Village

"We are the sharpest knives in the drawer!"

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Genesis of the project

- **Prior AWTS Wind-Diesel Activities**
  - R&D since mid1980s
  - Hydro Quebec Collaboration (1990s)
  - WDICS Development (2002)
- **Pre-commercial Chasm is Wide in Canada**
  - Limited R&D in Canada vs other countries
  - Little program support, for demo projects
  - Utilities (all large) wary of untested technology
- **Resource Constraints**
  - PPA offered modest (avoided cost)
  - Small team with severe financial constraints
- **Managing Risk Critical**

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Managing Risk - Ramea

- **Logistical** **(moderate risk)**
  - Site reasonably accessible
  - Ferry constraint for delivery of equipment
- **Technical** **(moderate/high risk)**
  - Turbine procurement / overhaul
  - Utility integration
- **Construction** **(moderate risk)**
  - Geo-technical
- **Operational** **(high risk)**
  - Integration issues
  - Transient Control
  - O&M
- **Financial** **(extreme risk)**
  - Financial resources fixed
  - PPA based on avoided cost
  - PPA made utility supreme
  - Declining load within community

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Selection of Ramea project site

- **Key customer (member of PPDIUC)**
  - Newfoundland & Labrador Hydro is a significant Canadian utility for isolated communities
  - NL Hydro key to opening Canadian markets.
- **Enthusiastic community support**
- **Good wind resource (7.5 m/s)**
- **Isolated yet accessible**
  - 1 day travel to site is ideal to resolve the inevitable problems that will arise on a demonstration project
- **Non-Arctic environment for initial project**
  - Enough uncertainties without adding Arctic challenges

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Understanding Utility Perspective

- **Wind-Diesel technology unproven**
  - **Reliability has not been demonstrated**
  - **Economics have not been favourable and**
  - **Impact on existing diesel system is unknown**

- **Utility realities**
  - **Mandate to supply reliable electricity at minimum cost**
  - **No R&D budgets**
  - **Limited resources (money and people). They are nearly overwhelmed just keeping the lights on.**
  - **Enthusiasm in wind energy will increase when they view wind as a cost effective alternative.**

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Ramea Project Objectives

- **Select a major Canadian utility with isolated communities and influence among utilities**
- **Demonstrate that**
  - **Wind technology is reliable**
  - **Wind and diesel systems are compatible**
  - **Economics can work under appropriate circumstances**
- **Set the stage for subsequent economic projects**

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Ramea Wind-Diesel Project

Small island 10 km from the south coast of Newfoundland

Population 700

Traditional fishery community

Collapse of Atlantic fishery has resulted in serious economic decline

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Ramea Electrical System

- System
  - Peak Load – 1,211 kW
  - Average Load – 528 kW
  - Minimum Load - 202 kW
  - Annual Energy – 4,556 MWh
- Distribution – 4160 Volts, 2 feeders
- Diesel Plant –
  - 3 - 925 kW Diesels (Cat 3512 – 1200 RPM)
  - Woodward Controls
  - Modicon PLC
  - Fuel Efficiency – 3.9 kWh/liter

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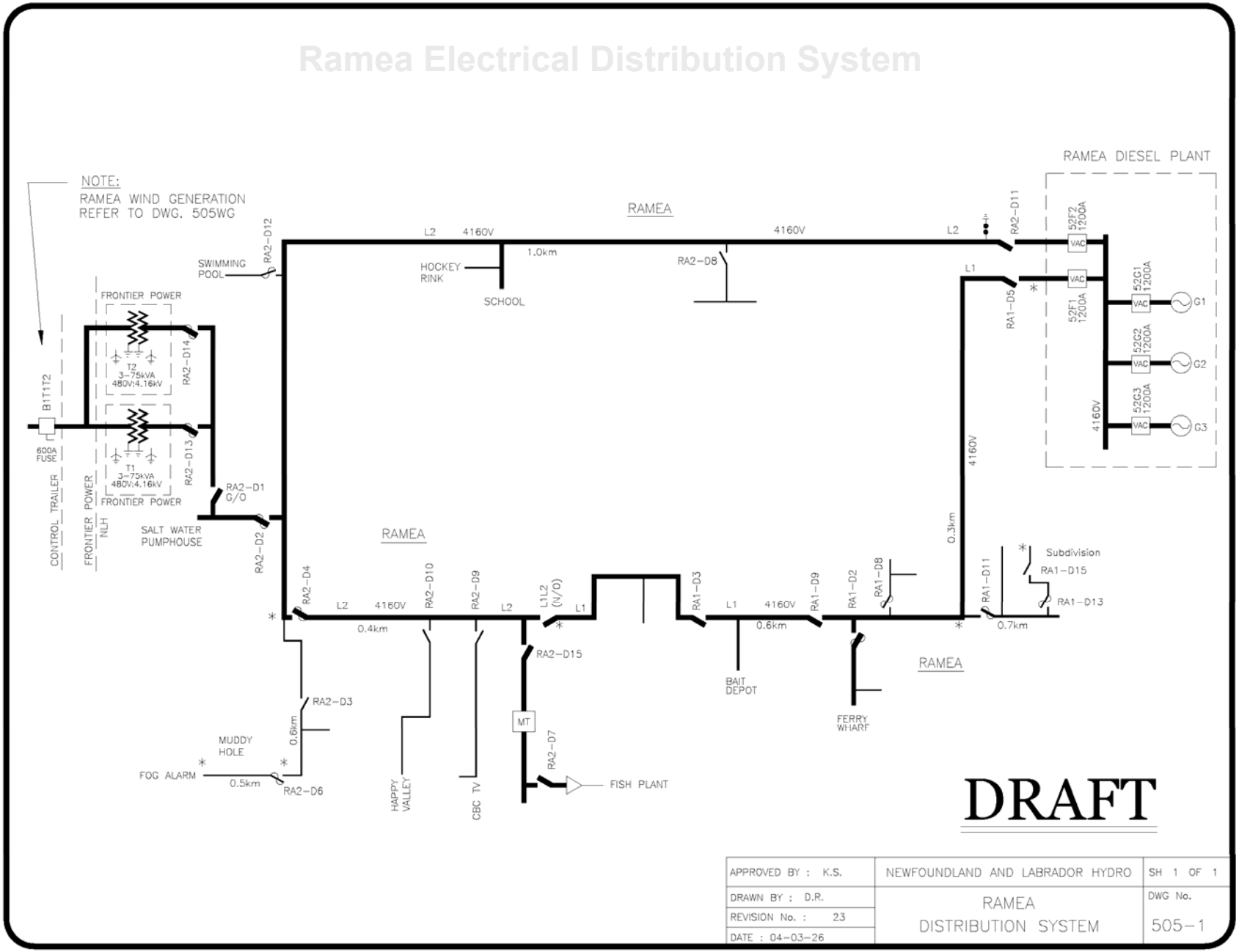
Ramea Electrical Distribution System



Equipment Installed

- **Six 65 kW Windmatic wind turbines**
- **Technology demonstration project**
- **WDICS** (Wind-Diesel Integrated Control System)
  - System Master
  - Wind Plant Master
  - Load Regulator
  - Diesel Plant Communication Package
  - SCADA with internet access (continuous monitoring with 1 Hz and ten minute data acquisition)

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Windmatic WM15S

- State of the art mid-80s Danish turbine
- 15 meter rotor
- Three blade, stall regulated
- Upwind design, Forced Yaw
- 25 meter free-standing tower
- Reconditioned by FPS

- Why reconditioned turbines? - $$$$

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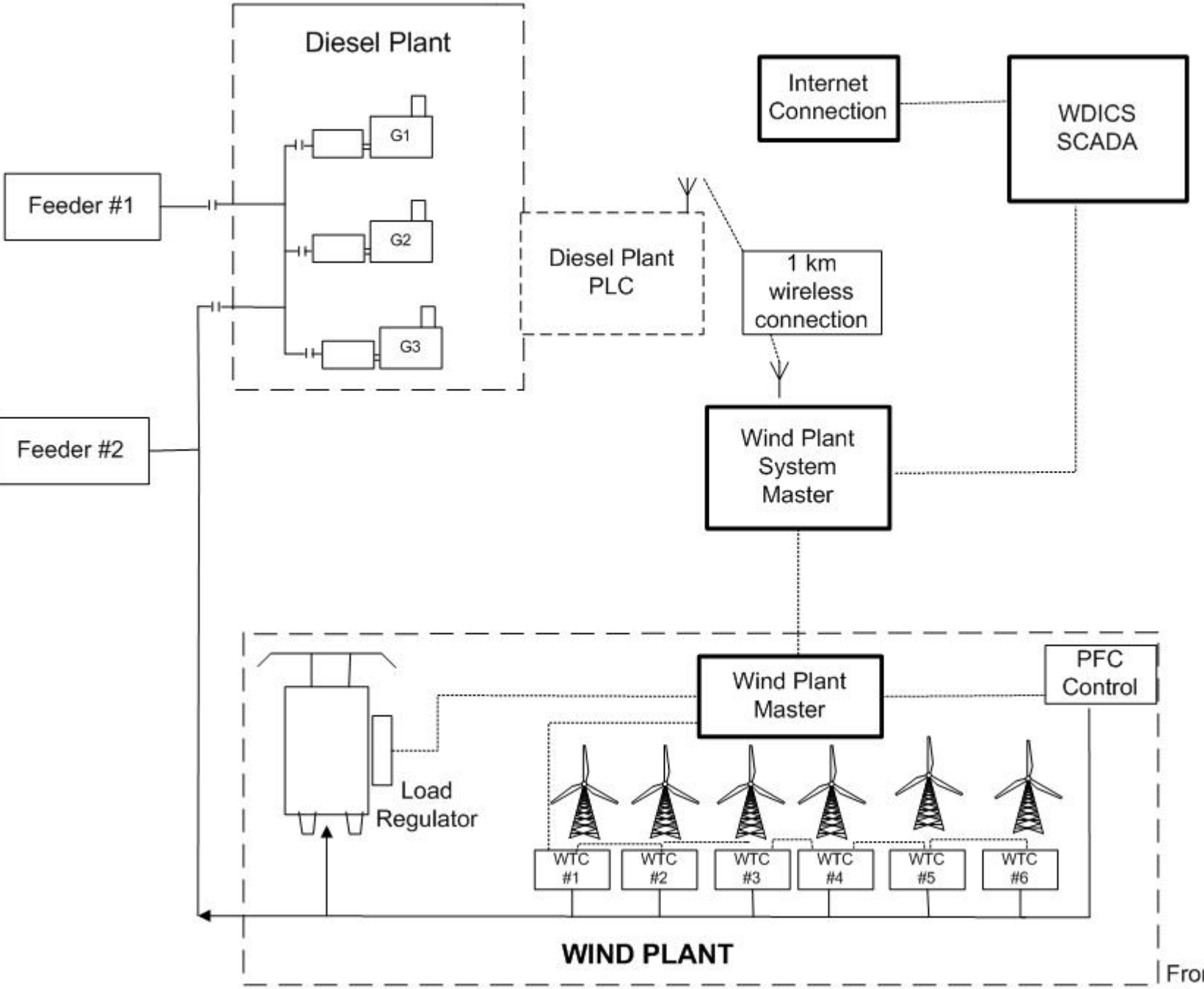
WDICS Configuration



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Wind Plant System Layout

Operational Results

- 400 kW wind on 700 kW load has visible impact on diesels
- Voltage quality issues during connection
  - Improved with recent changes
  - Additional improvements pending
- Frequency stability affected but within limits
  - +/-0.01Hz. Variation no wind
  - +/-0.1 Hz. Variation with 400 kW wind
- Fuel savings have been less than projected
  - Lower power output in high winds (Initially reduced pitch on turbine blades to ensure there were no stability problems)
  - Reliability issues on re-conditioned turbines (retrofits have improved circumstances but re-conditioned turbines bring difficulties or costs)
  - Loads decreasing / diesels oversized
- Fuel savings will increase with changes implemented

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Improvements

- **Increased Energy Production**
  - **More aggressive blade pitching**
    - **Increased power output has not increased impact on diesel plant**
  - **Improved turbine reliability**
    - **Rebuilt turbines have been economic but onerous**
- **Technology Enhancements**
  - **Improved SCADA and Control Systems**
  - **Updated Load Regulator**
    - **New platform significantly improved response and control**

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Future Work

- **Technology Enhancements**
  - **Improve Communication Platform** (2008)
  - **Voltage stabilizer** (May'08)
  - **Power stabilizer** (2008-09)
- **Follow-on Project Work**
  - **One More Design Iteration to Commercial Deployment (**PEI Wind Hydrogen Village-2007-08**)**
  - **Commercial offering 2008-09**

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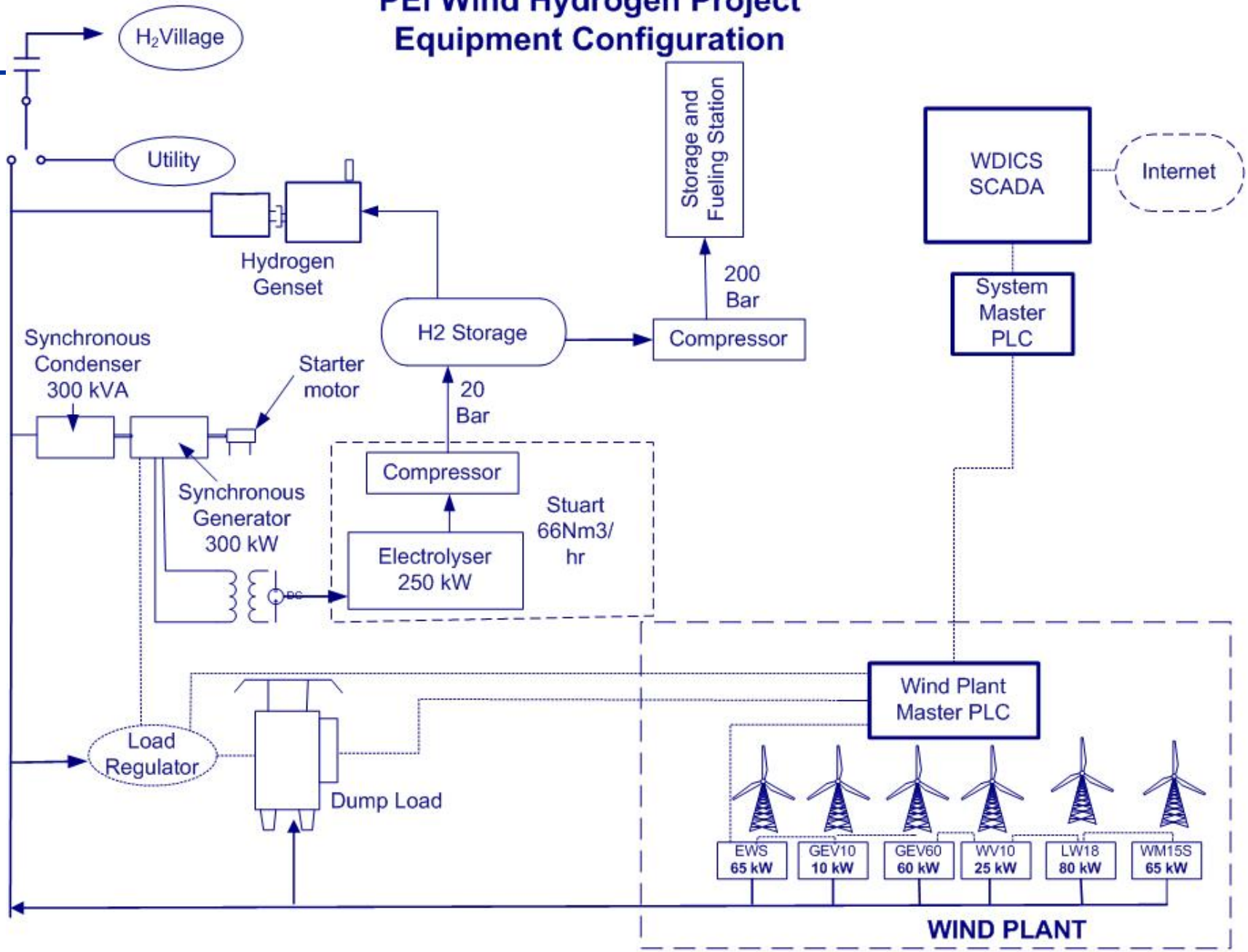
PEI Wind Hydrogen Project
Equipment Configuration



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Hydrogen Village Issues
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Lessons Learned

- Utilities slow to embrace wind-diesel - Ramea has been important to engage key utility
- We must offer systems to meet utility's criteria
- Problems are inevitable in early demo projects. We found lots!
- Identified many technical deficiencies.
  - We understand all of them better. Some have been resolved. Remaining are being addressed.
- Project provided invaluable experience in understanding unique requirements of community wind applications - Few have acquired our field experience.

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Forecast - Bright skies with cloudy periods

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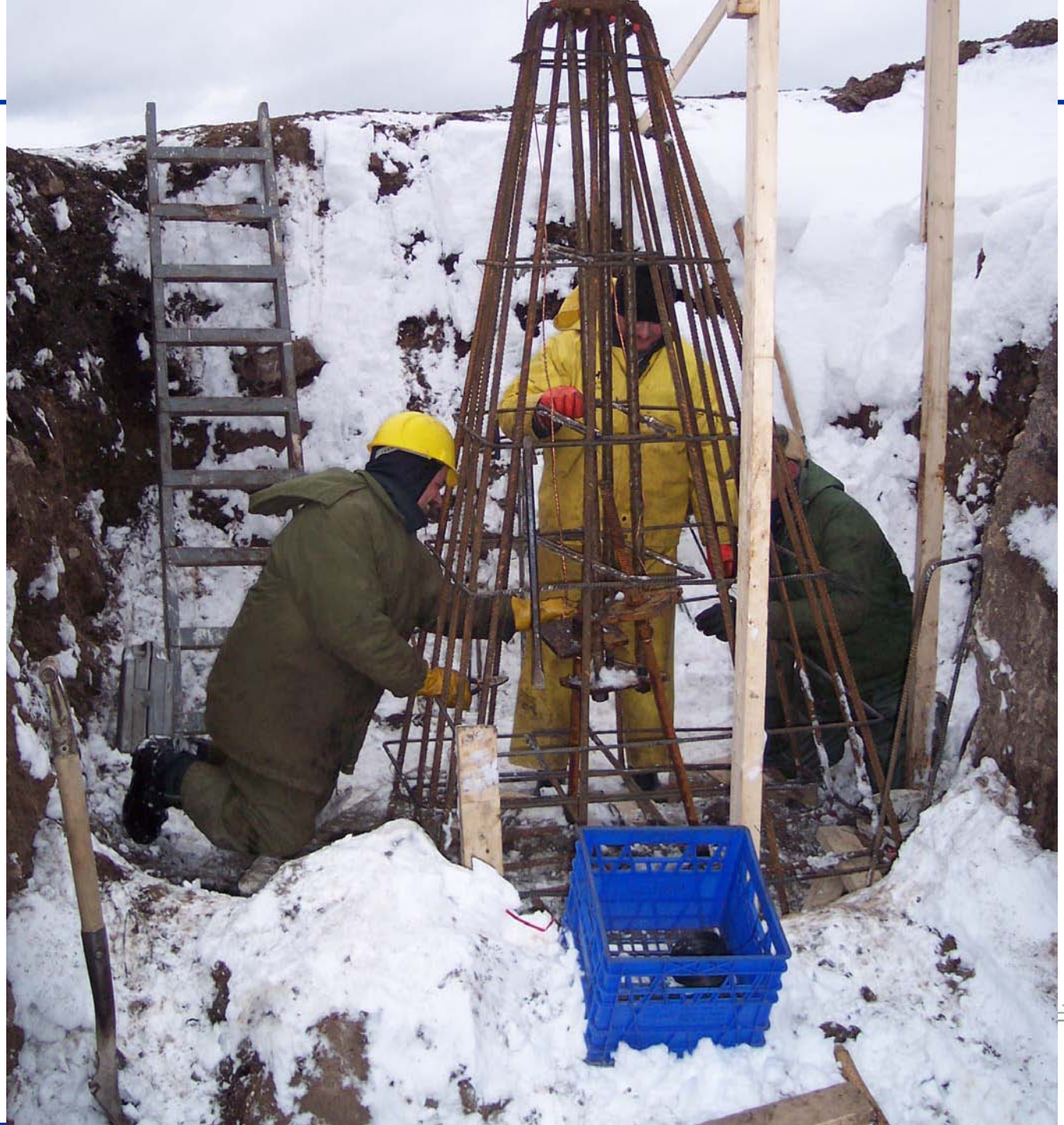

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Pump Load
ON
OFF