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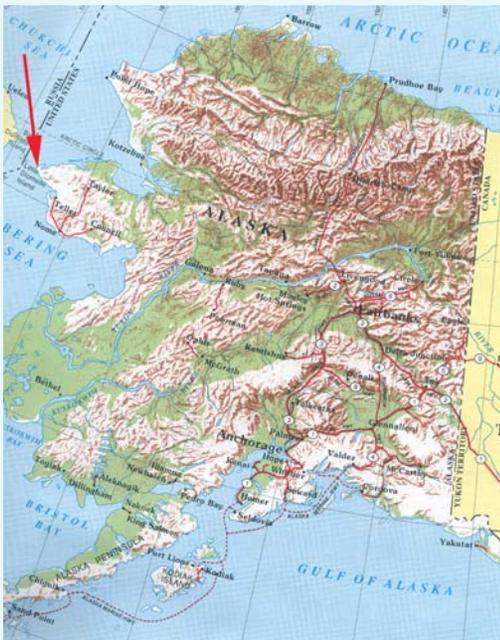
# **Overview of the High Penetration Wind-Diesel System in Wales, Alaska**

**Steve Drouilhet  
Sustainable Automation, LLC**



# Wales Wind-Diesel System Overview

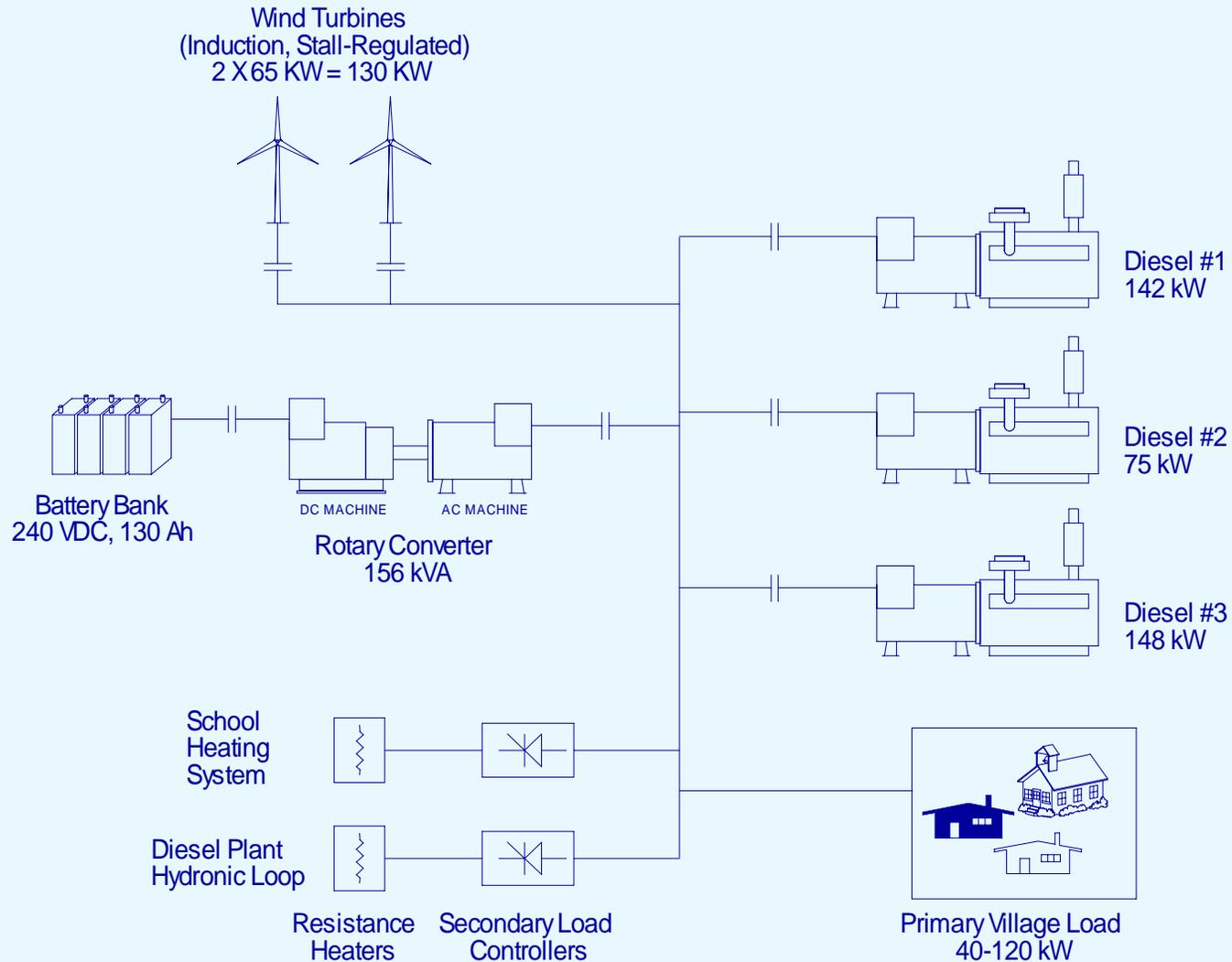
- 160 person village
- Avg. load ~ 70 kW
- Installed: Summer 2000
- In partial operation since October 2000
- Fully commissioned March 2002





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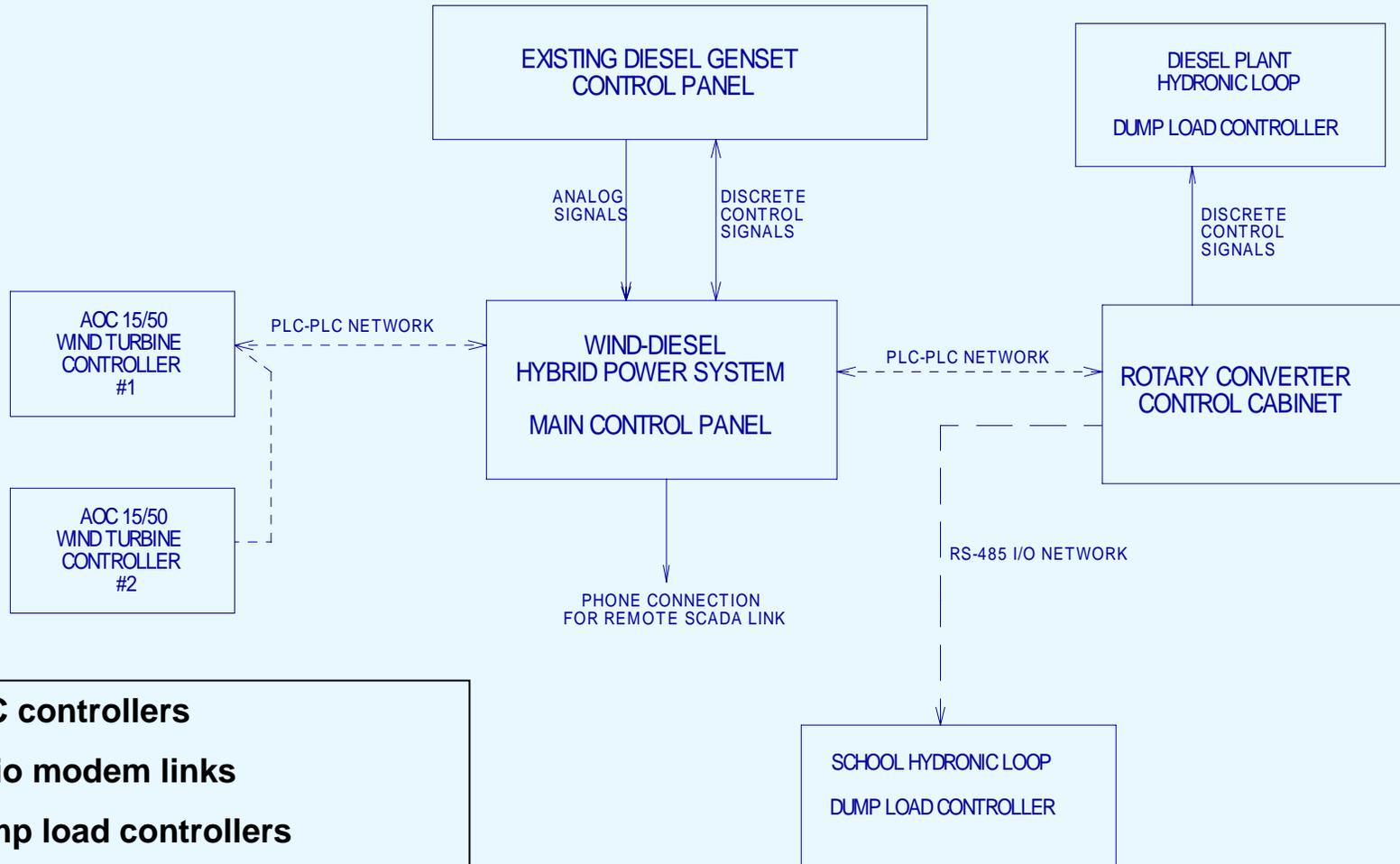
# Wales, Alaska Wind-Diesel System Architecture





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# Wales Wind-diesel System Communication And Control



**4 PLC controllers**  
**2 radio modem links**  
**2 dump load controllers**  
**phone link**



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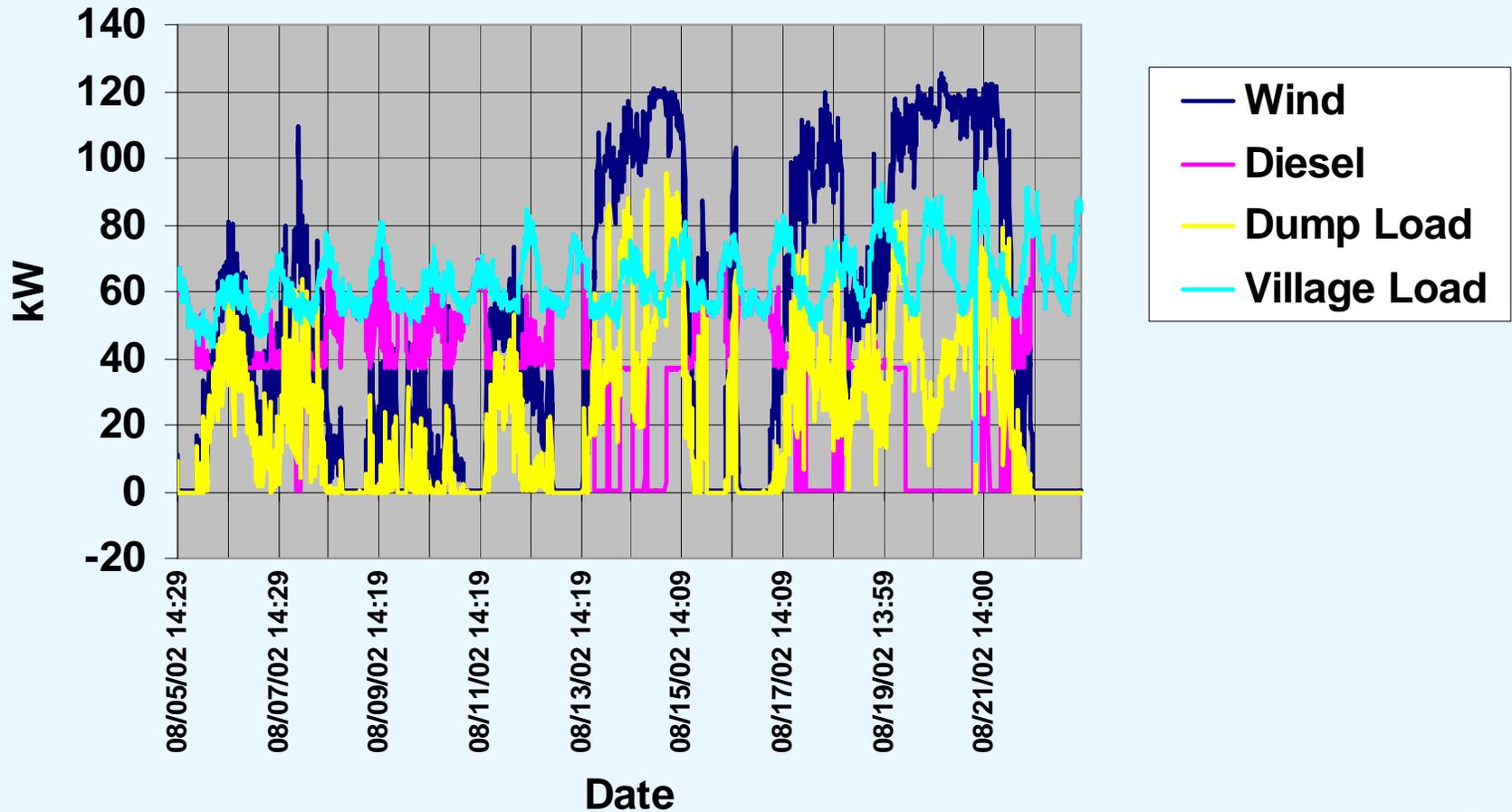
## **Wales System Technical Objectives**

- **Demonstrate reliable operation of high penetration system**
  - **Appropriate component dispatch**
  - **Smooth transitions between diesel-on and diesel-off operation.**
- **Fuel Savings**
  - **With 2 turbines, projected wind penetration ~ 70%**
  - **fuel savings ~ 45%**
  - **Projected reduction in diesel run time ~ 25%**
- **Power Quality**
  - **Good voltage regulation**
  - **Good frequency regulation**
  - **No noticeable impact on consumers**



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## Wales System 10-minute Power Averages August 5-23, 2002





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# Wales Project Energy Flows

## August 5-23, 2002

(427 hr. in reporting period)

	kWh	Fraction of primary load
<b>Village Load (Primary Load)</b>	<b>26,950</b>	<b>100%</b>
<b>Diesel Energy Output</b>	<b>15,970</b>	<b>59%</b>
<b>Wind Energy</b>	<b>21,080</b>	<b>78%</b>
<b>Wind Energy to Primary Load</b>	<b>10,980</b>	<b>41%</b>
<b>Wind Energy to Dump Load</b>	<b>9,430</b>	<b>35%</b>
<b>Wind Energy to RC losses</b>	<b>670</b>	<b>2%</b>

		Annual Projection
<b>Diesel Fuel Saved (gallons) (13 kWh/gallon)</b>	<b>845</b>	<b>17,340</b>
<b>Heating Fuel Saved (gallons) (127,000 Btu/gal = 30 kWh/gal)</b>	<b>119</b>	<b>2,440</b>



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# **Wales Wind Turbine Productivity**

## **August 5-23, 2002**

**(427 hr. in reporting period)**

	<b>Turbine 1</b>	<b>Turbine 2</b>
<b>Average Wind Speed (m/s)</b>	<b>7.1</b>	<b>6.8</b>
<b>Availability</b>	<b>99%</b>	<b>99%</b>
<b>Capacity Factor (rated = 65 kW)</b>	<b>0.382</b>	<b>0.377</b>
<b>Projected annual energy output per turbine (kWh)</b>	<b>216,000</b>	



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# **Wales Diesel-Off Statistics**

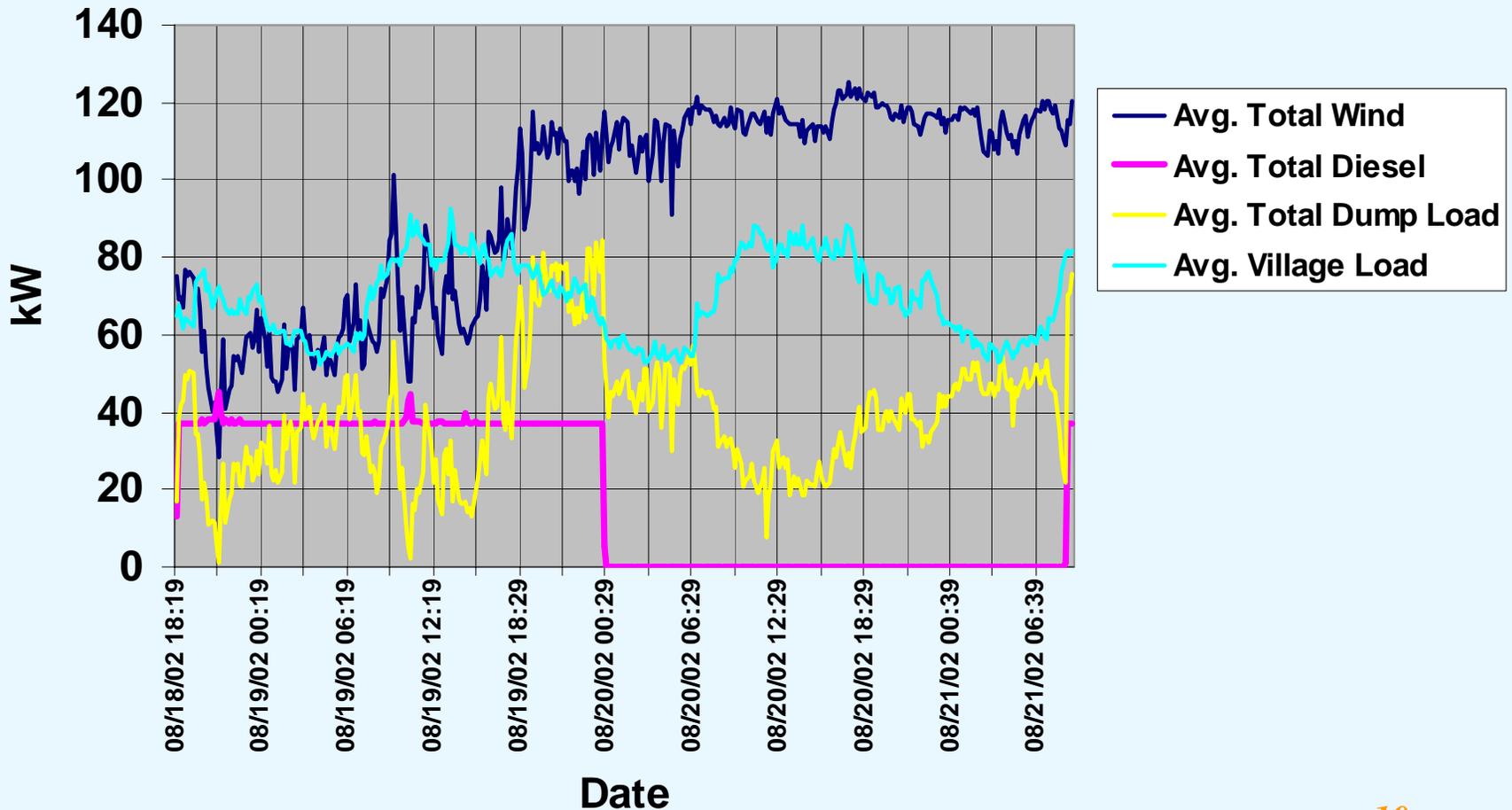
## **August 5-23, 2002**

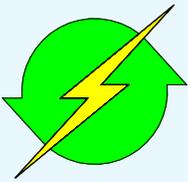
- **Length of reporting period:** 427 hours
- **Amount of diesel-off time:** 87 hours (20%)



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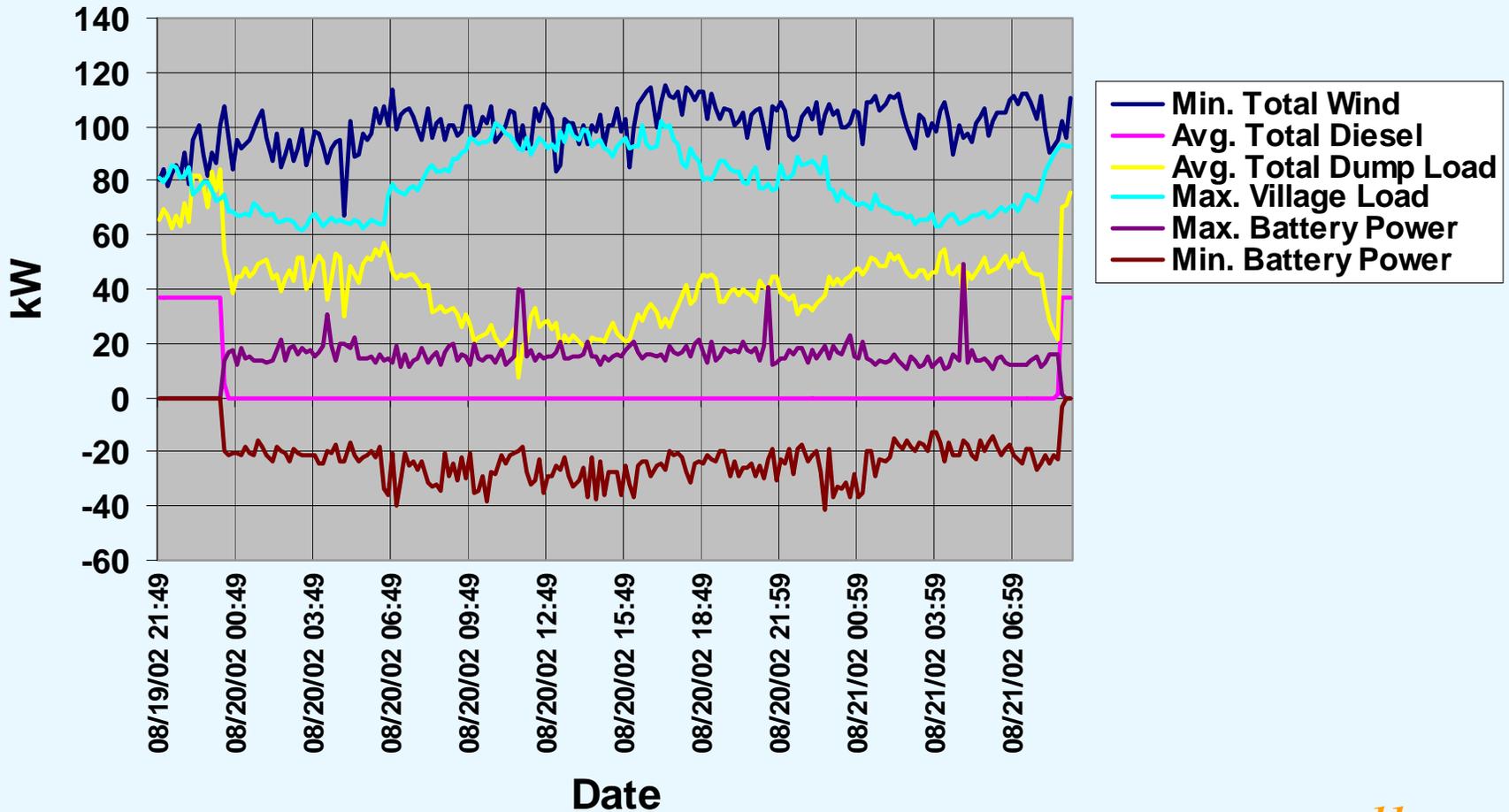
## Wales System 10-min Power Averages August 18-21, 2002

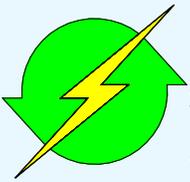




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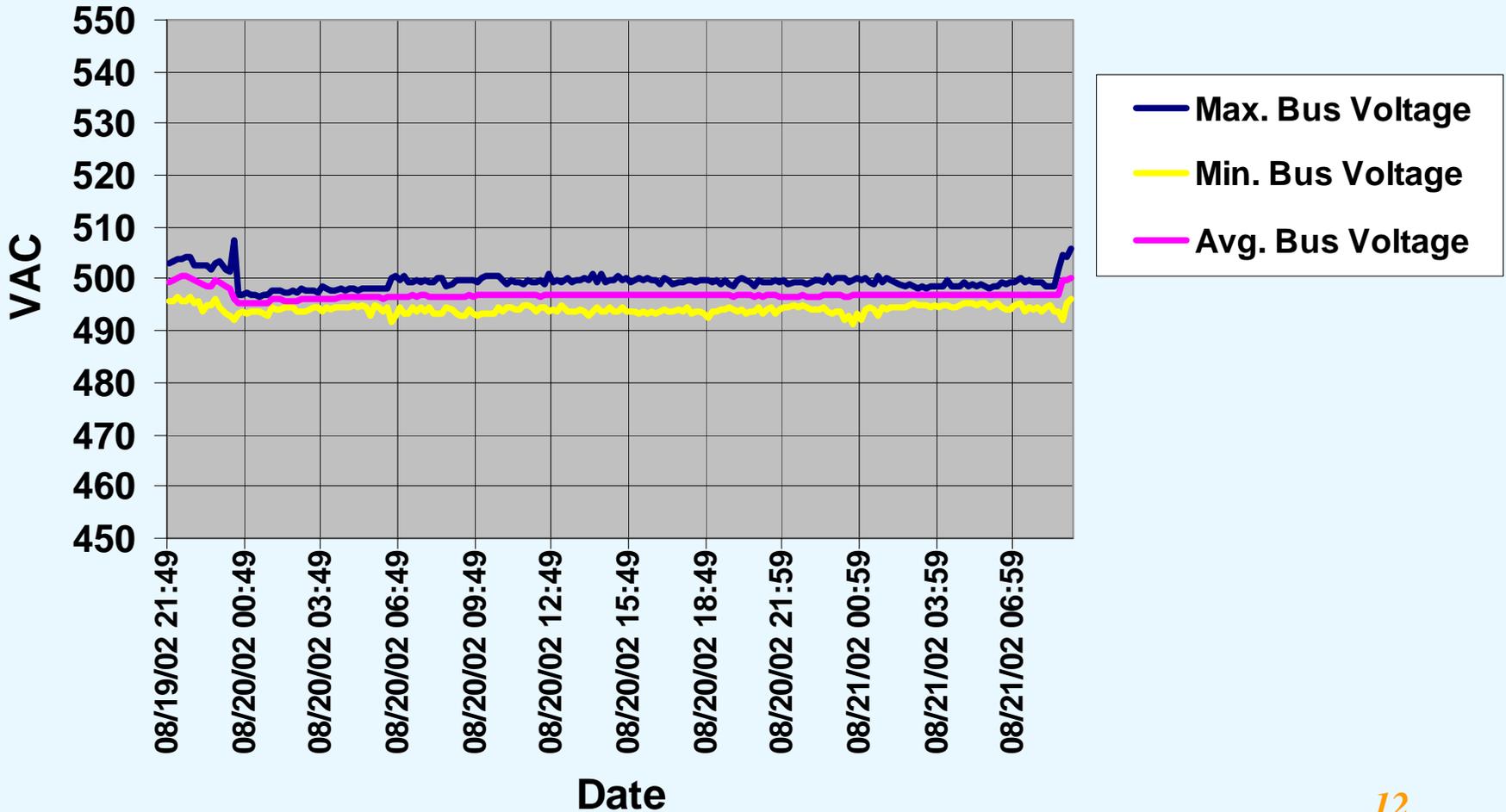
## Wales System Power Flows August 19-21, 2002





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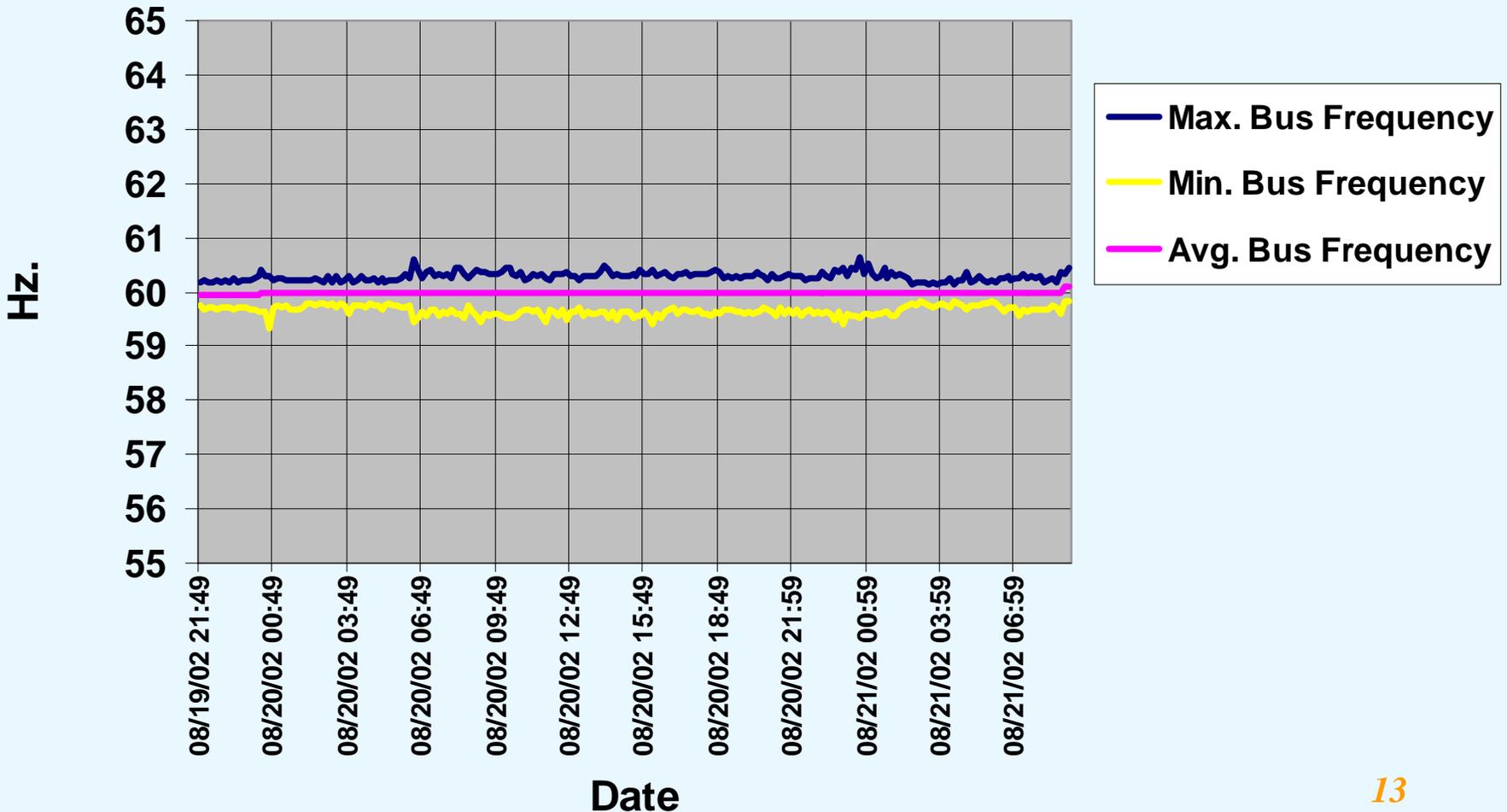
## Wales System Bus Voltage August 19-21, 2002





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## Wales System Bus Frequency August 19-21, 2002





## **Current Activities**

- **Address factors limiting diesel-off operation.**
  - **Replace temperature control valve in diesel waste heat loop.**
  - **Replace Generator #2 with new Detroit Diesel genset.**
- **Upgrade wind turbines for improved availability.**
  - **Tip brake retrofit**
- **Improve ability to remotely monitor and support the system**
  - **Install broadband Internet connection to power plant**
  - **Put all PLC controllers on an Ethernet LAN**