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**power** corp

# ***Wind-(Hydro)-Diesel Power Systems***

- Flores Island, Azores Portugal***
- Graciosa Island, Azores Portugal***

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# *Integration of Renewables*

## *Penetration*

- Low penetration (0 – 25%)
  - Easy
  - Simply negative load
  - Little effect on frequency or voltage
- Medium penetration (25 – 50%)
  - Getting more difficult
- High penetration (> 50%)
  - Almost impossible
  - Problems with
    - Frequency
    - Voltage
    - Stability
    - Faults

# Summary of Wind/Diesel

<b>Station</b>	<b>No. Generators</b>	<b>No. WTG</b>	<b>Wind</b>	<b>Diesel</b>
Denham	7	4	1,200kW	1,600 kW
Mawson	4	2	600kW	550kW
Esperance	14	15	5,600kW	14,500kW
Hopetoun	8	2	1,200kW	2,560 kW
Cocos Island	5	4	100kW	950kW
Bremer Bay	4	1	600kW	1,250kW
<b>Coral Bay</b>	<b>8</b>	<b>3</b>	<b>825kW</b>	<b>2,560kW</b>
<b>Graciosa</b>	<b>5</b>	<b>4</b>	<b>800kW</b>	<b>3,200kW</b>
<b>Flores</b>	<b>8</b>	<b>2</b>	<b>600kW</b>	<b>4,000kW</b>
Rottneest	7	1	600kW	1,300kW
<b>TOTAL:</b>	<b>70</b>	<b>38</b>	<b>12.125MW</b>	<b>32.47MW</b>

# Flores Island

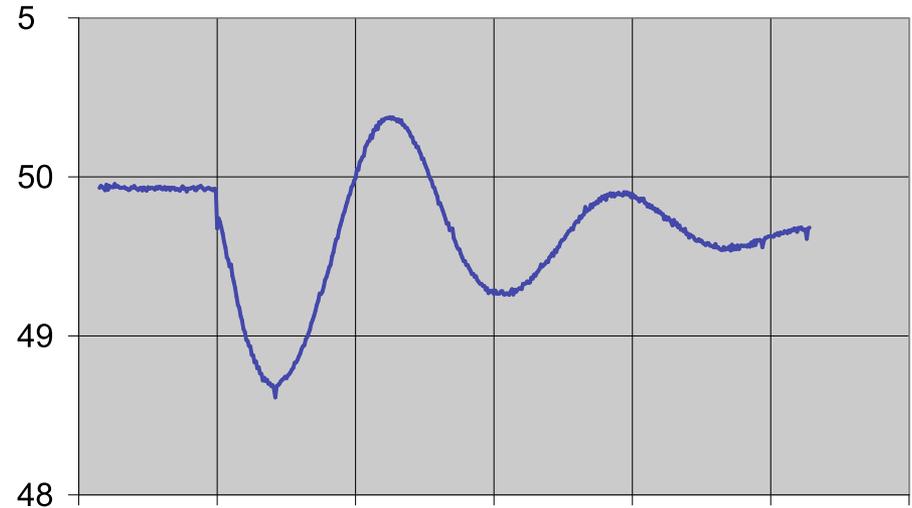
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# Renewables in Isolated Systems

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## Problem: Frequency Stability



- 600kW of wind in a 2MW power system was totally unstable
- Wind gusts would excite resonance
- Voltage fluctuations would trip WTGs; cascading trips
- Wind power was manually limited to 300 - 400kW to avoid blackouts

# Results: Flores, Azores

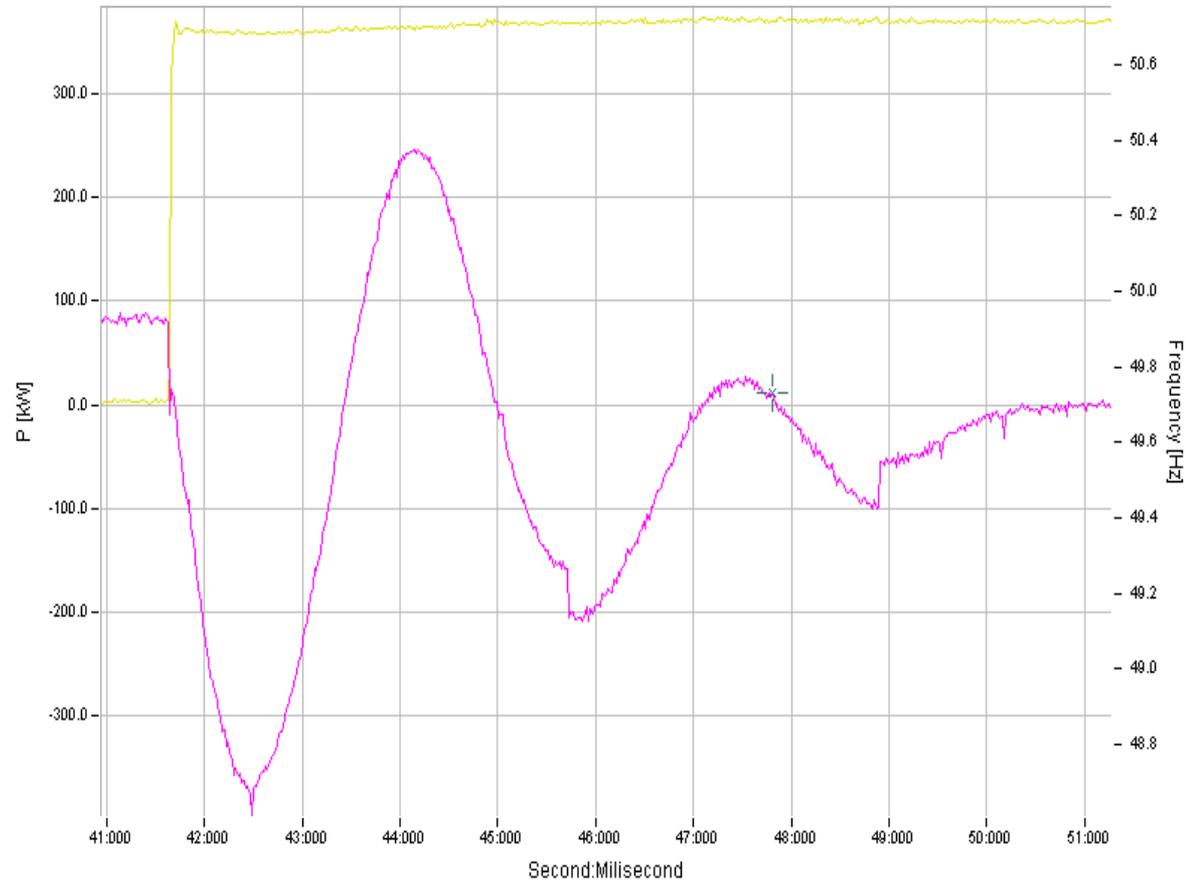
## Integration using PowerStore: Flores, Azores



# Results: Flores, Azores

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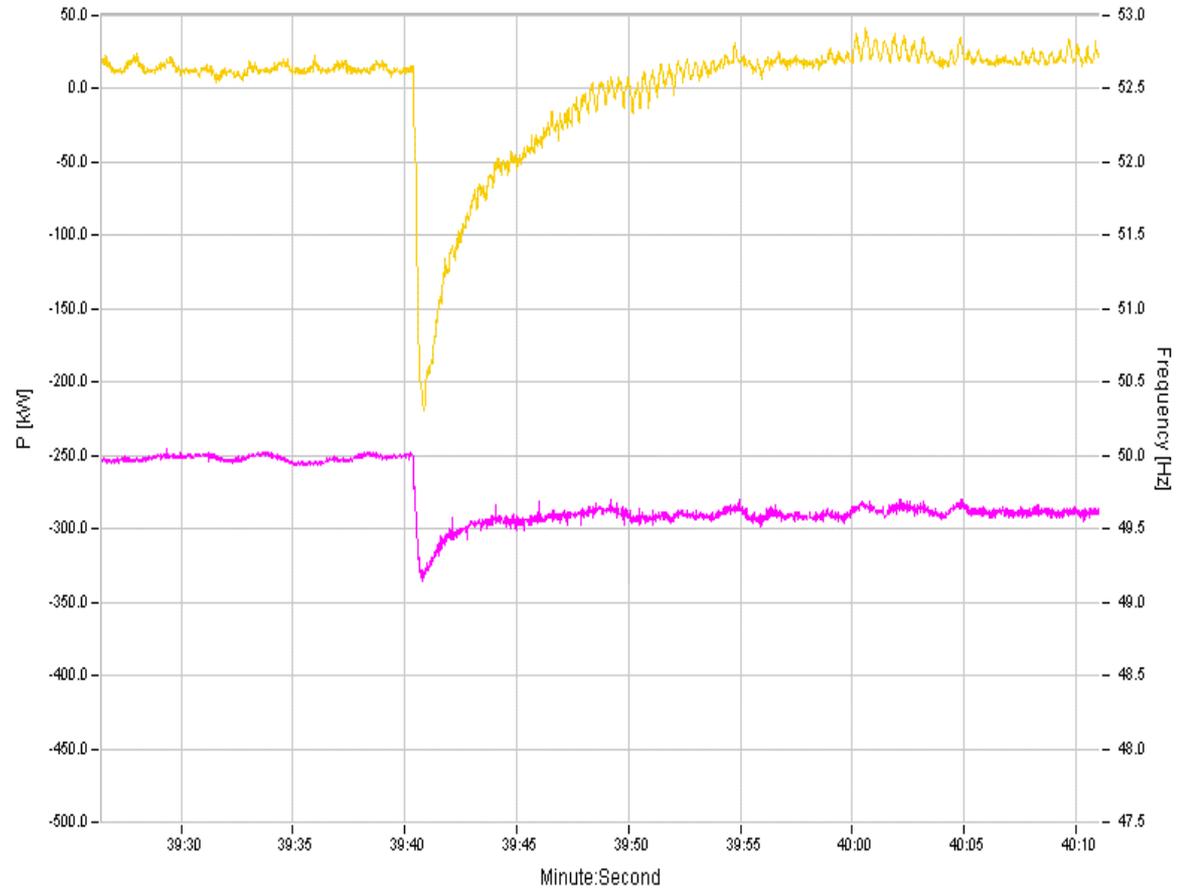
## Before



# Results: Flores, Azores

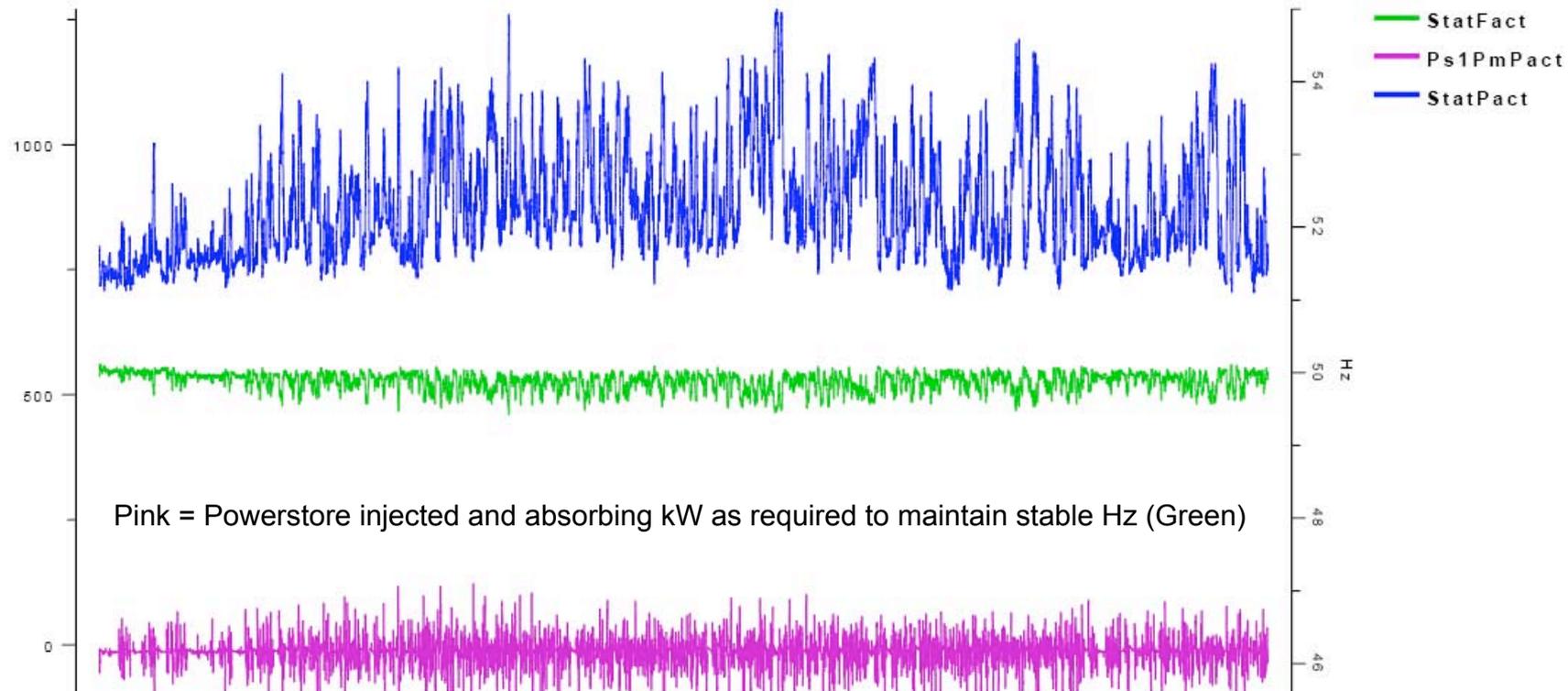
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## After



# Higher Wind Penetration

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10:33:20  
Tue 06-Jun-06

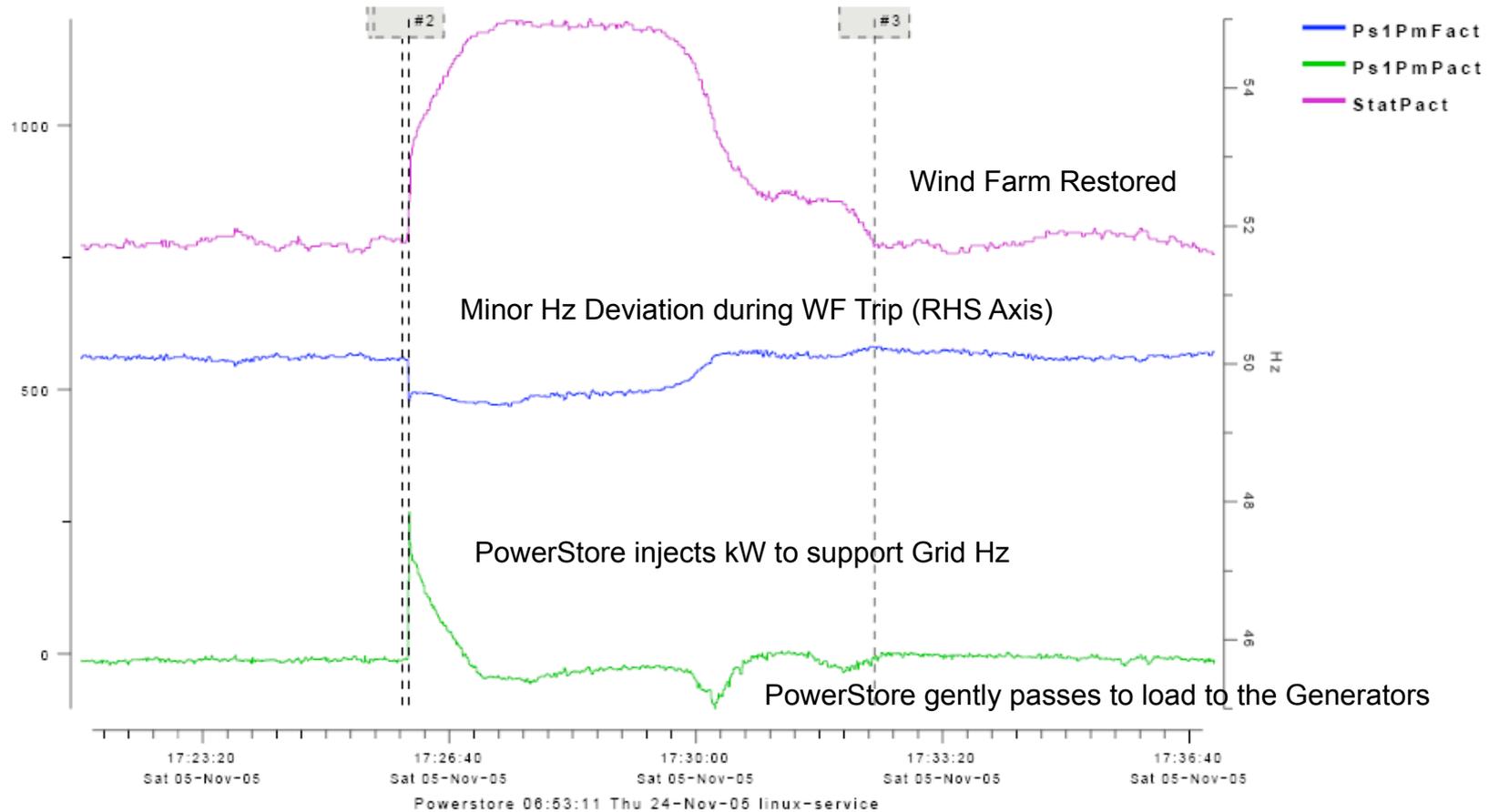
13:20:00  
Tue 06-Jun-06

00:16:38 Fri 09-Jun-06 localhost

# Wind Turbines Unlimited

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Wind Farm Trip = >500kW Step  
Onto Power Station of only 750kW load!



# Results: Flores, Azores

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## Final Outcomes

- System stable
- Able to run WTGs in unlimited power mode
- No cascading trips of WTGs
- Extra line fault capability
- More than average 50% renewable penetration
- Next step is to run in renewables-only mode



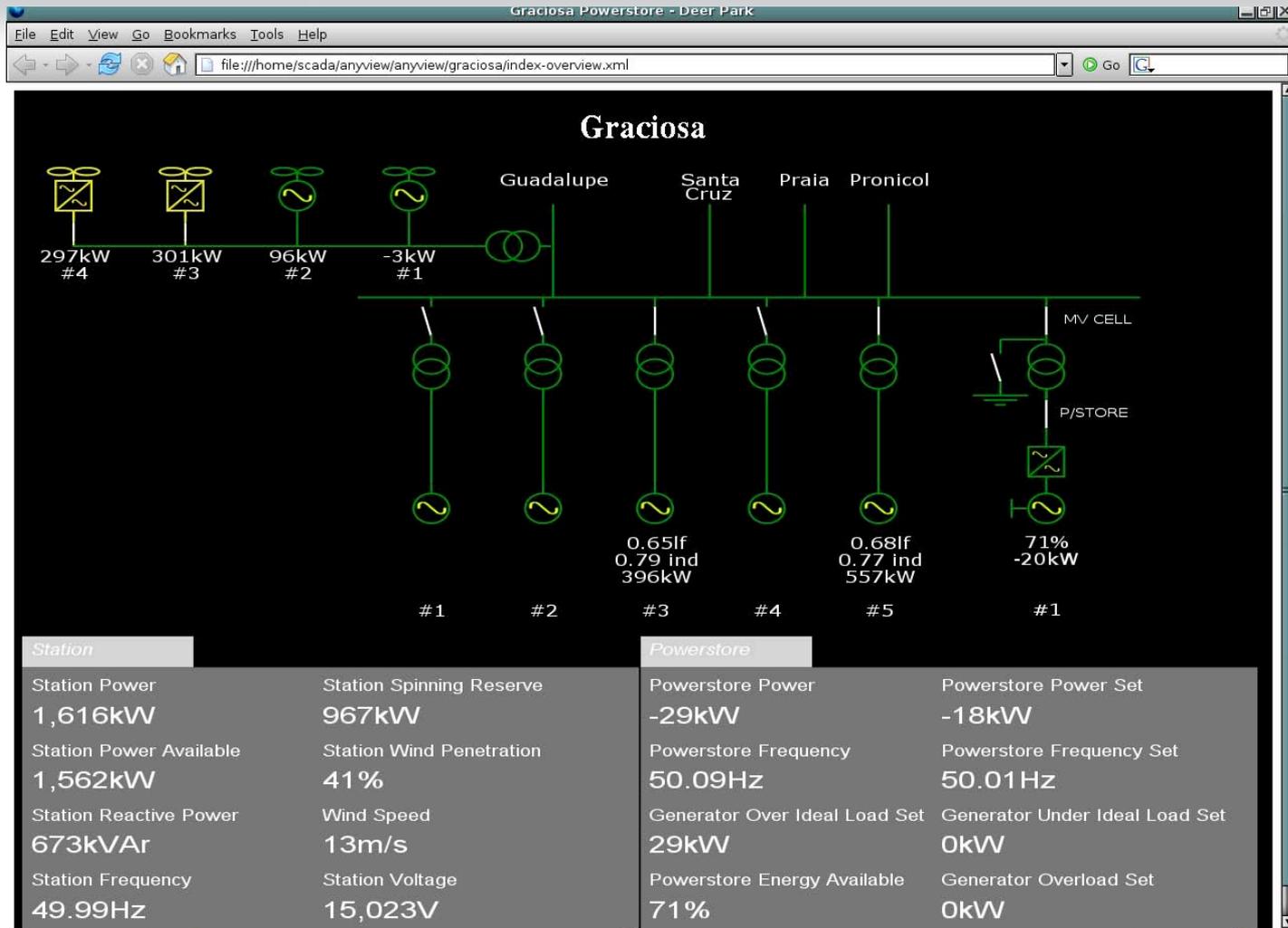
# Graciosa Wind/Diesel PowerStore

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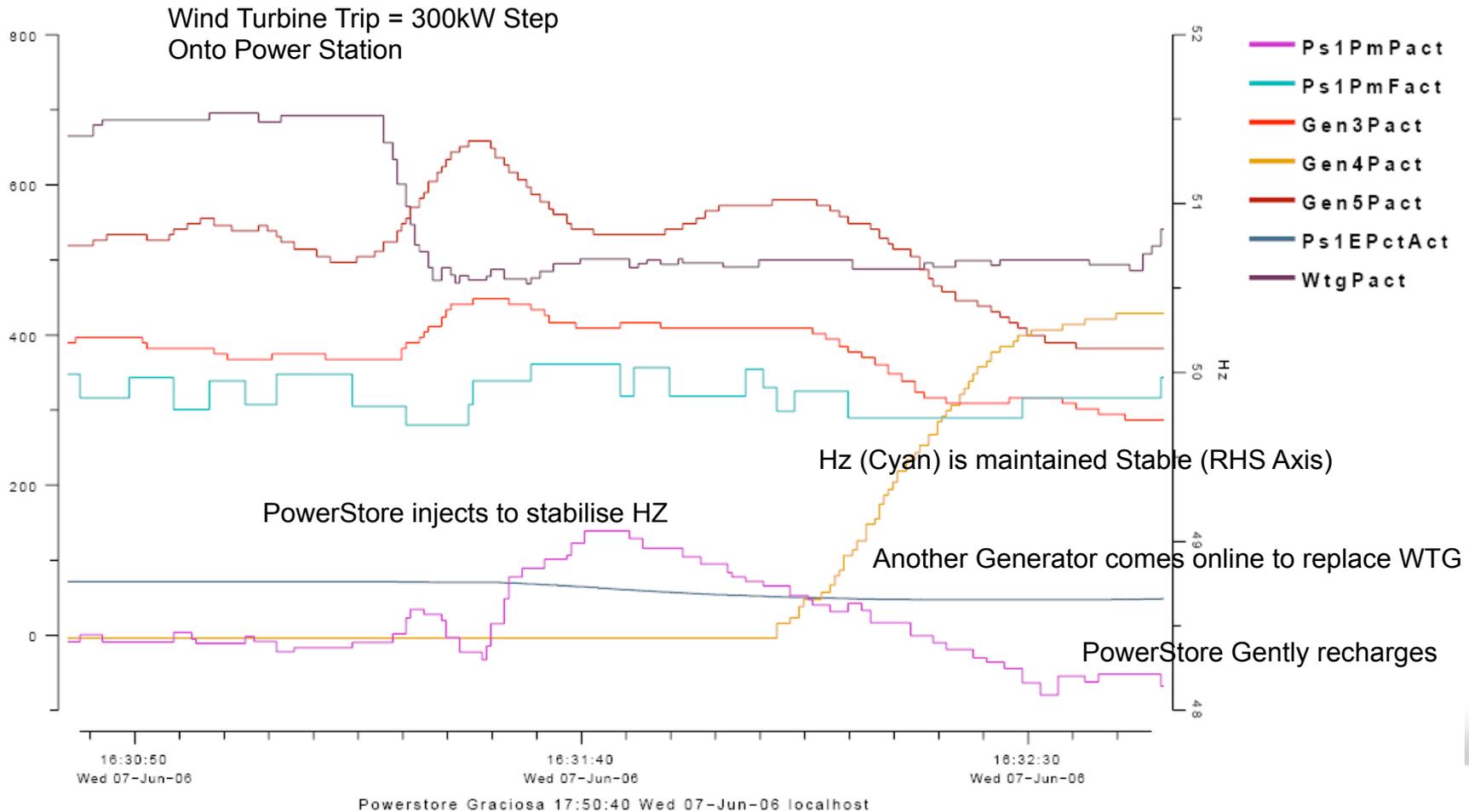
# Graciosa Wind/Diesel

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# Results: Increased Wind Penetration

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# *Flores Virtual Tour*

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