Vestas Wind Systems A/S

Wind Power Plant Control

Introduction

- In the good old days
- Not so many years ago
- Today
- Platforms
- PPC
- PPC modules
- Active power control
- Reactive power control
- Scheduling and ramping
- Substation and grid protection
- Substation control
- Substation monitoring
- Other controls
- Configuration
- Controller restart
- Reporting

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In the good old days

- Connect the turbines to the grid and the job is done
- No reactive power requirements on farm level
- No active power requirements on farm level
- No signals from the utilities or from the customer
- SCADA system monitoring turbines and turbines only

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Not so many years ago

- Few (= none) requirements on active production. Constant reference to protect equipment or even open loop control
- No reactive power requirements on farm level
- Few (= no) signals from utilities or from the customer
- SCADA system monitoring turbines and maybe a few signals

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Today

- Almost every site has active power requirements. Runback scenarios, power ramping, frequency response capabilities etc.
- Many sites have reactive power requirements. Reactive power control. Voltage control and protection. Power factor control.
- Control of substation equipment (capacitor banks, SVC equipment, circuit breakers)
- Monitoring of hundreds of digital and analogue signals from substation equipment
- Control signals from utilities and customers
- Park status and substation status feedback to utilities and customers
- SCADA system monitoring turbines and entire substation
- Power plant control independent of SCADA server

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Platforms

- Power Plant Server (PPS)
  - Support for 3rd party OPC servers
  - IO through external equipment (PLCs, ION meters etc.)
  - Turbine and substation monitoring and alarm dial out
  - Turbine and substation event and data logging
- Power Plant Controller (PPC)
  - A better PLC – you can program complex protocols. Currently AP, DCE3, Modbus Master (TCP/IP and serial), DNP3 slave (serial)
  - Plenty of I/Os
  - Designed for a rough environment
  - Real-time OS - guaranteed response time
  - Embedded
  - Data logging
  - Own grid measurements

Active Power Control

- Feedback or open loop control
- Pitch control
- Pause/run control
- Combination of pitch control and pause/run control (in development)
- Delta control (spinning reserve)
- Runback scenarios
- Multiple simultaneous set points with logging of who is the currently responsible

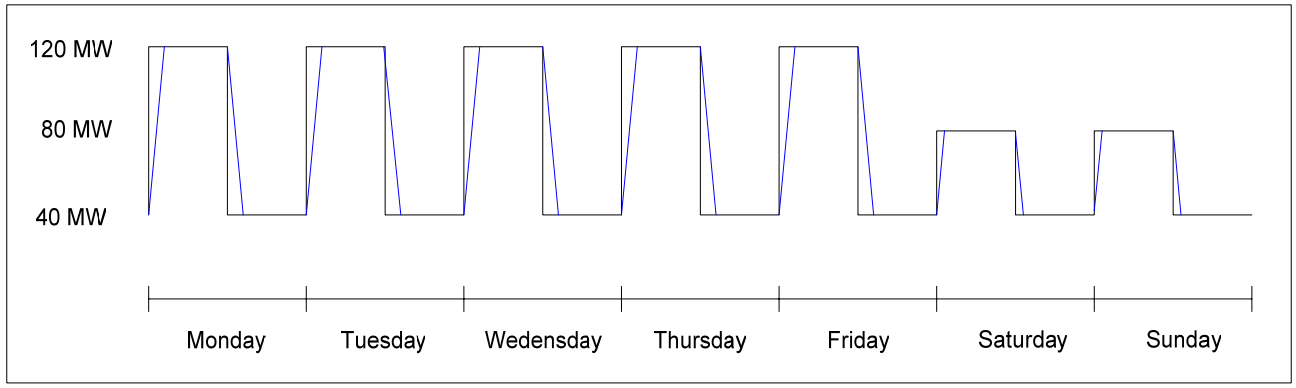
- Set points from various sources
  - Hardwired analogue or digital signal
  - Utility PLC
  - Communication protocols (Modbus, DNP3, etc)
  - Predefined schedules
  - Operator set point in VestasOnline Business Solution or WEB page in Power Plant Controller

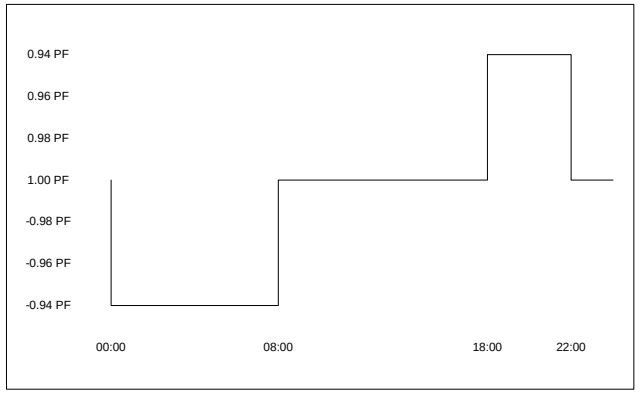
Reactive Power Control

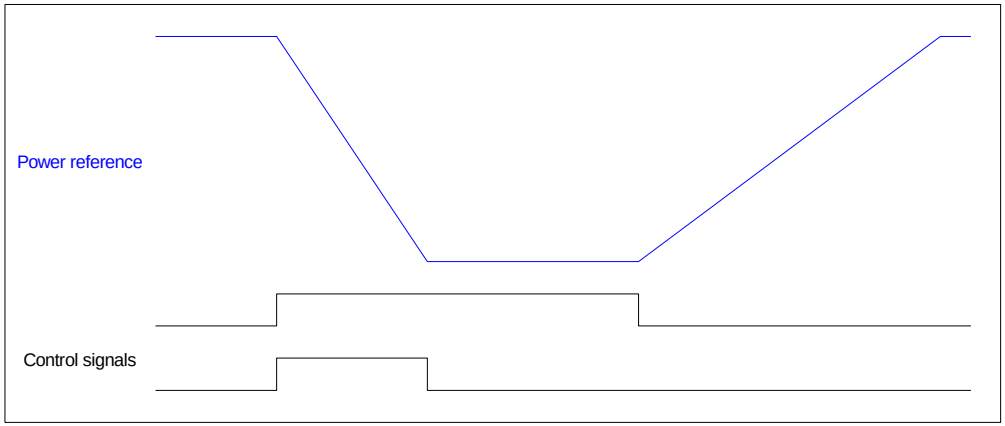
- Feedback or open loop control
- kVAr control
- Power factor control
- Voltage control and voltage protection
- Turbines can work in cooperation with SVC equipment and/or capacitor banks

Scheduling and ramping

- Many possibilities for advanced schedules and ramps







Substation and grid protection

- Preemptive voltage control and protection
- Runback scenarios
- Temperature protection
- Fast turbine cut-out

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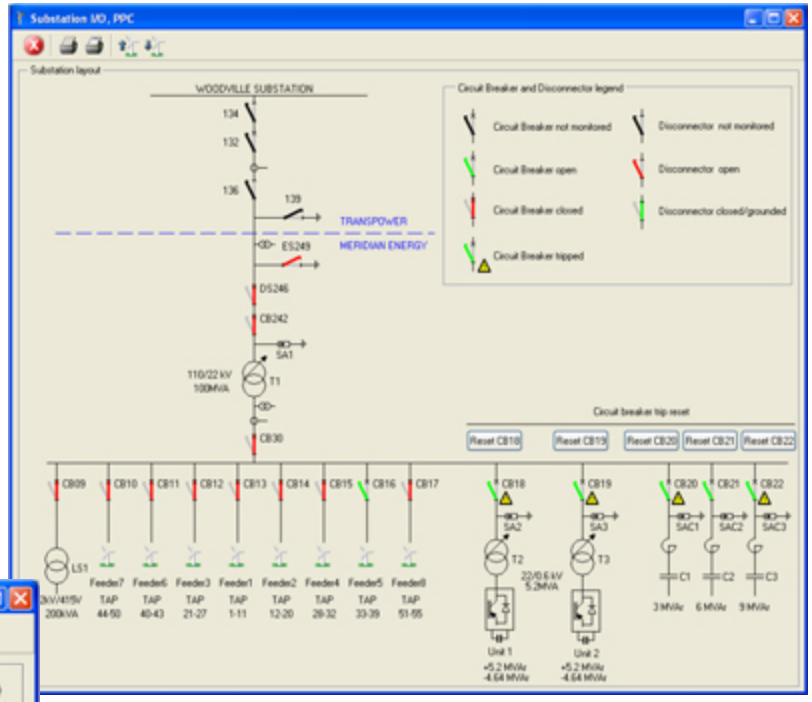
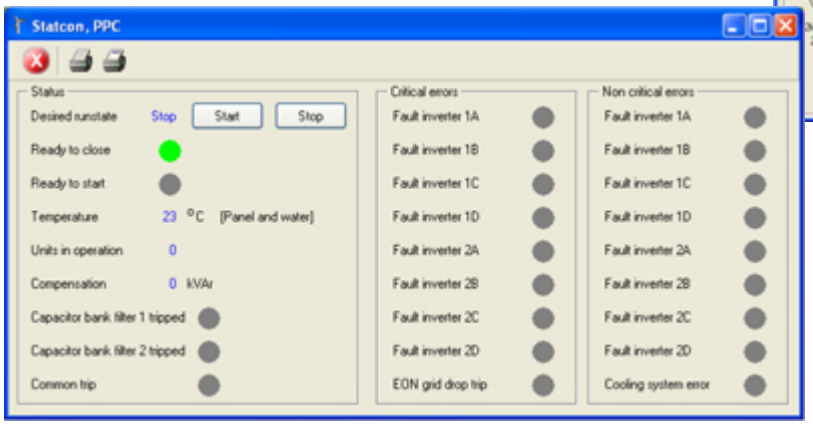
Substation control

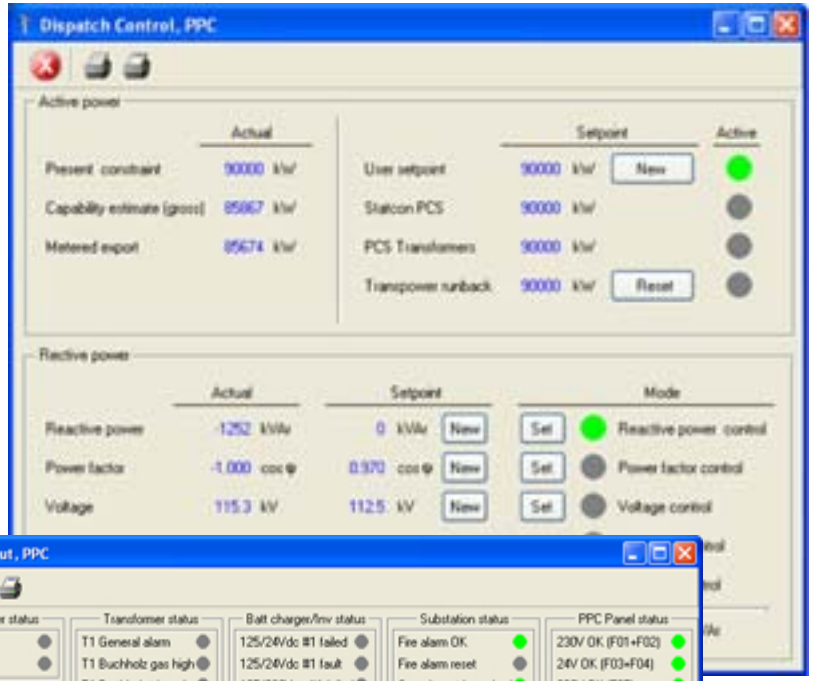
- Breaker switching
- Breaker monitoring and tripping
- Tap changer control

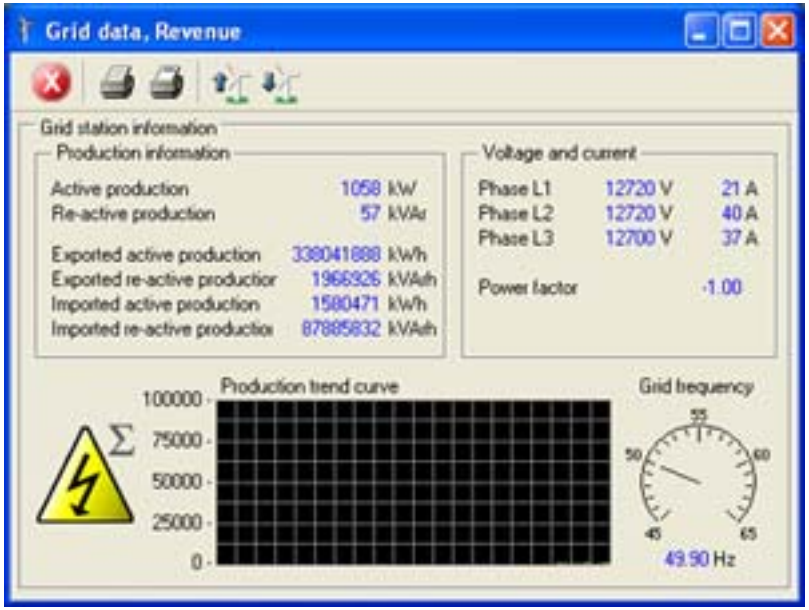


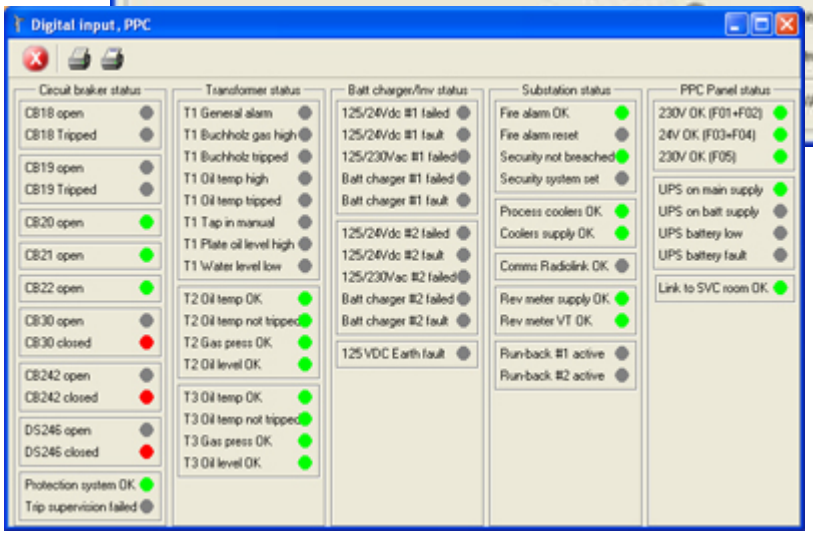


Substation monitoring

- Data collection
- Event collection
- Monitoring and trending
- Alarm annunciation
- Alarm dial-out







Additional control

- Flicker control
- Noise control
- Cut-in management

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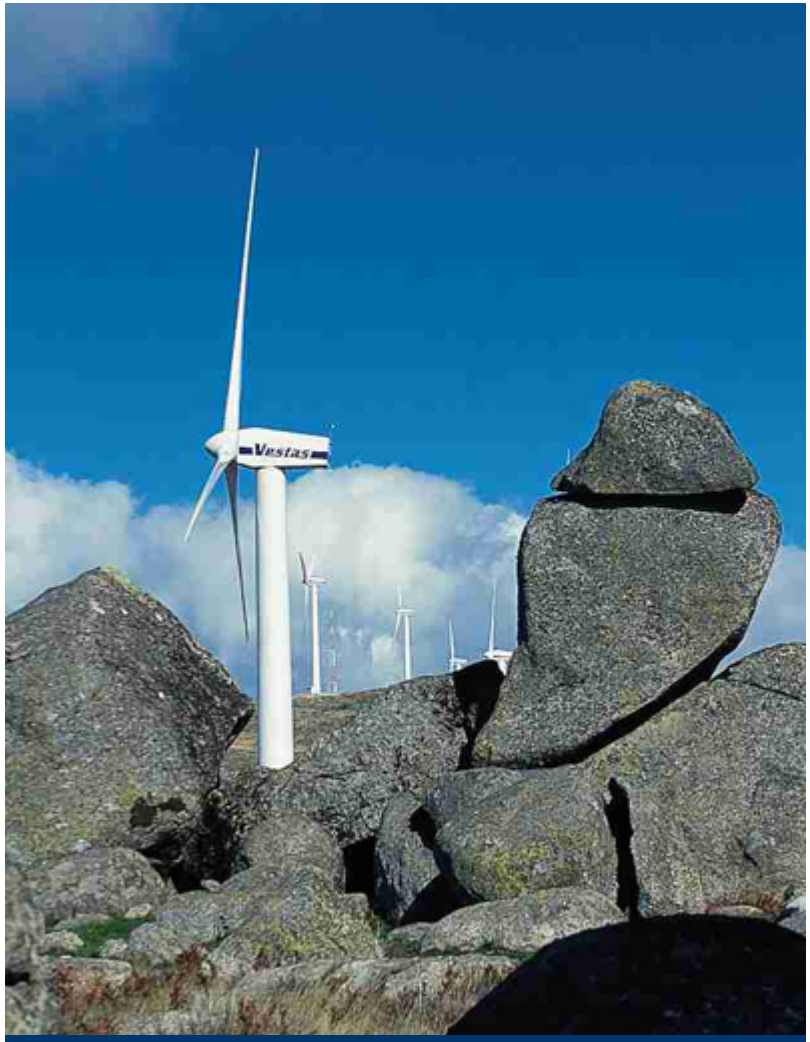
Reporting

- Reference responsible stored in 10-minute data in the turbine
  - Utility
  - Owner
  - Manufacturer
  - Power management
  - Curtailment
  - Environmental

- Reports answering questions like
  - How much production has been lost due to thermal constraints?
  - How big a bill can we send to X for production loss in April due to SVC problems



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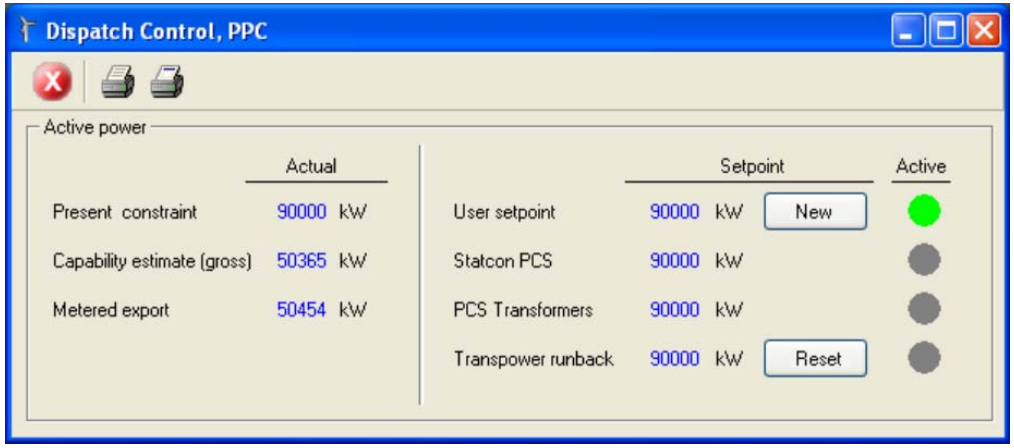
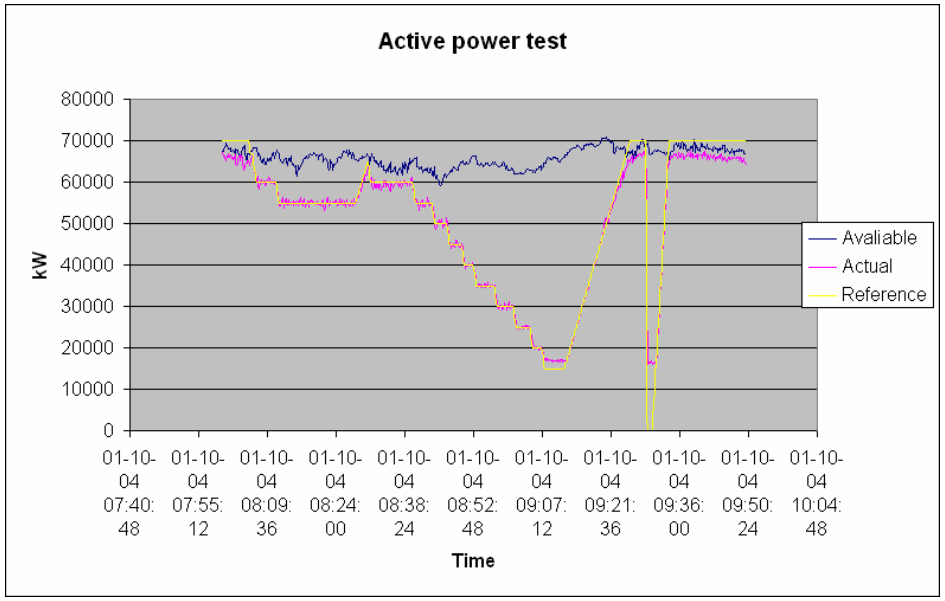
Te Apiti Active Power

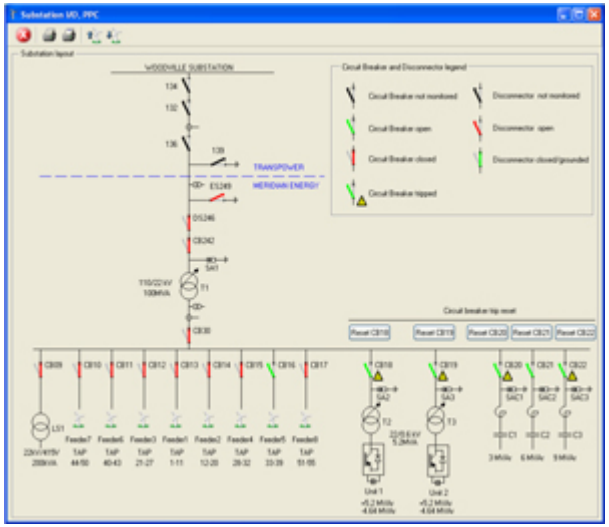
- User constraint
- Protection constraint
- Utility runback

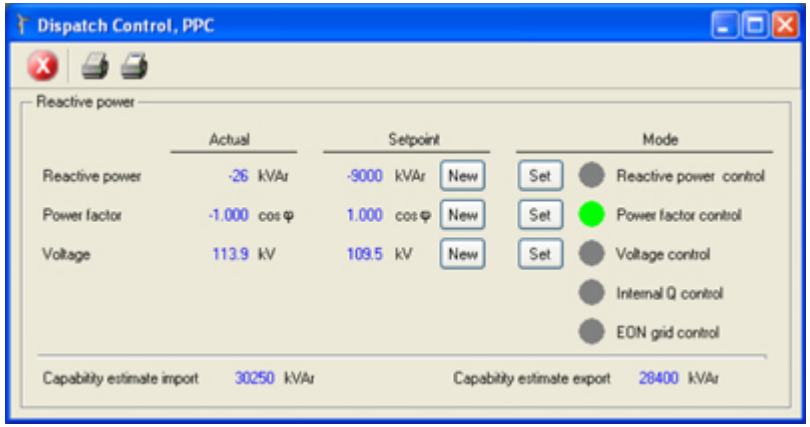




Te Apiti (Reactive power demands)

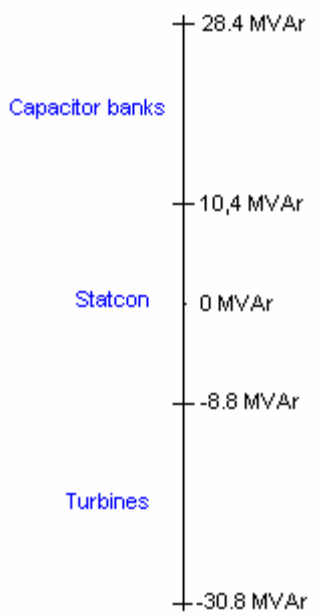
- Power factor adjustable from 0.95 capacitive to 0.95 inductive - precision of 0.001
- kVAr adjustable from -30 MVAr to 28 MVar. Precision better than 50 kVAr
- Settling time < 1 second

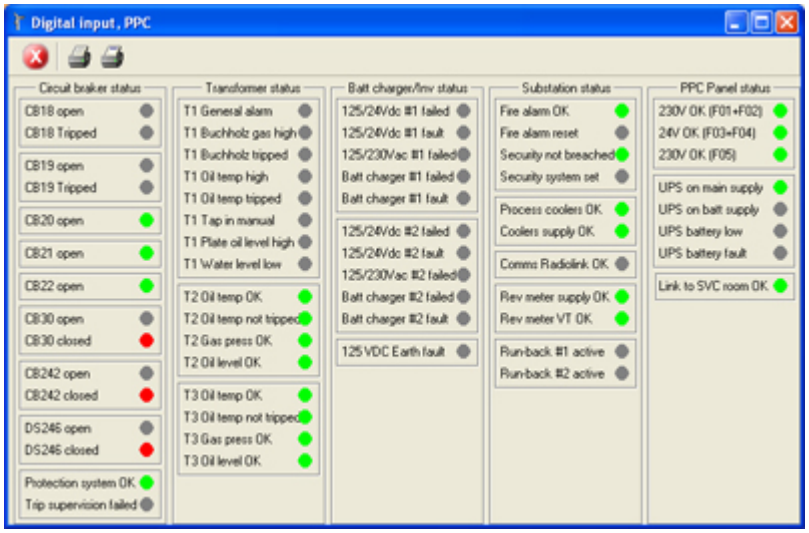
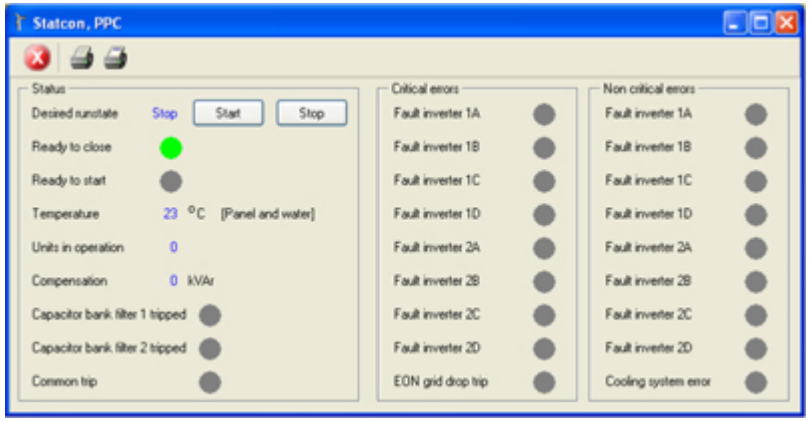




Te Apiti (Reactive power solutions)

- -9 to + 10 MVAr Statcon
- 3 MVAr, 6 MVAr and 9 MVAr capacitor banks
- 850 kVAr in each turbine



Te Apiti additional demands

- Monitoring of 350 I/O signals
- Protection of transformers