Integrating Wind Resources

Meeting the challenge

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PSE PUGET SOUND ENERGY
The Energy To Do Great Things

Overview

- Puget Sound Energy

- Brief History

- Real Power

- Reactive Power

- Looking Forward

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Puget Sound Energy

Vertically integrated

> 1 million electric customers

772 MW of wind power

…added since 2005

8% wind-generated

PSE Resource by Generation Type

- CT
- CCCT
- Coal
- Wind
- Hydro

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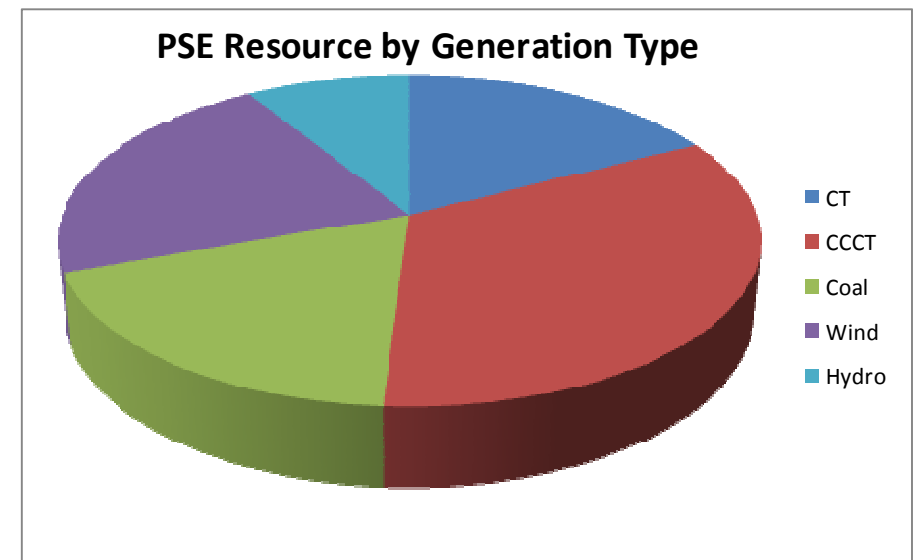
Back in the day…

'Kilowatt class' turbines

A large wind farm was10 MW

Induction machines

Free-running

Soft-starters

Some capacitor compensation

Minimal impact on the grid

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State of the Art Today
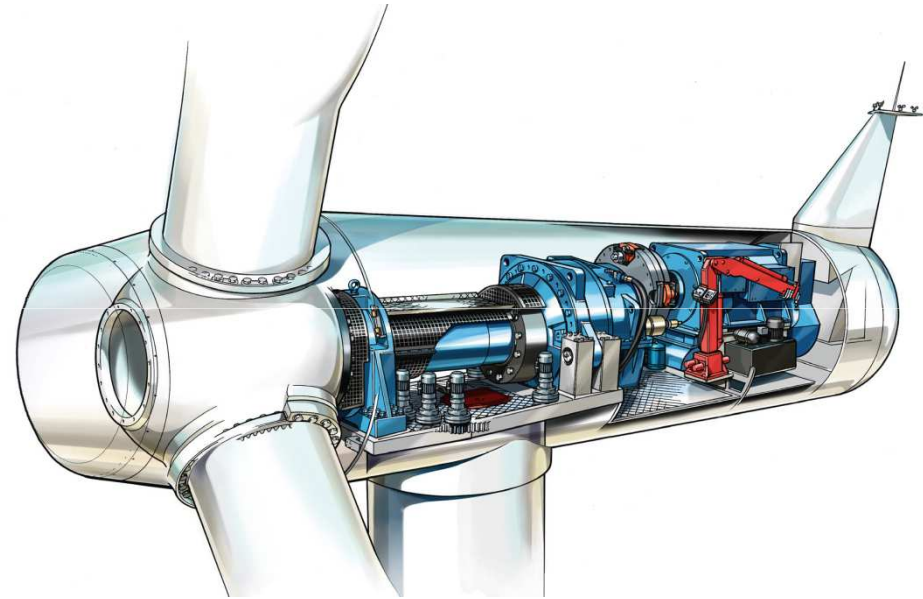
1.5 – 3.0 MW turbines

500 MW wind power plants

Full power electronics

Plant real power control

Plant reactive power control

LVRT, voltage support, reserve

'Looks like' a traditional synchronous generator

Example – Wild Horse

149 Turbines – 272 MW

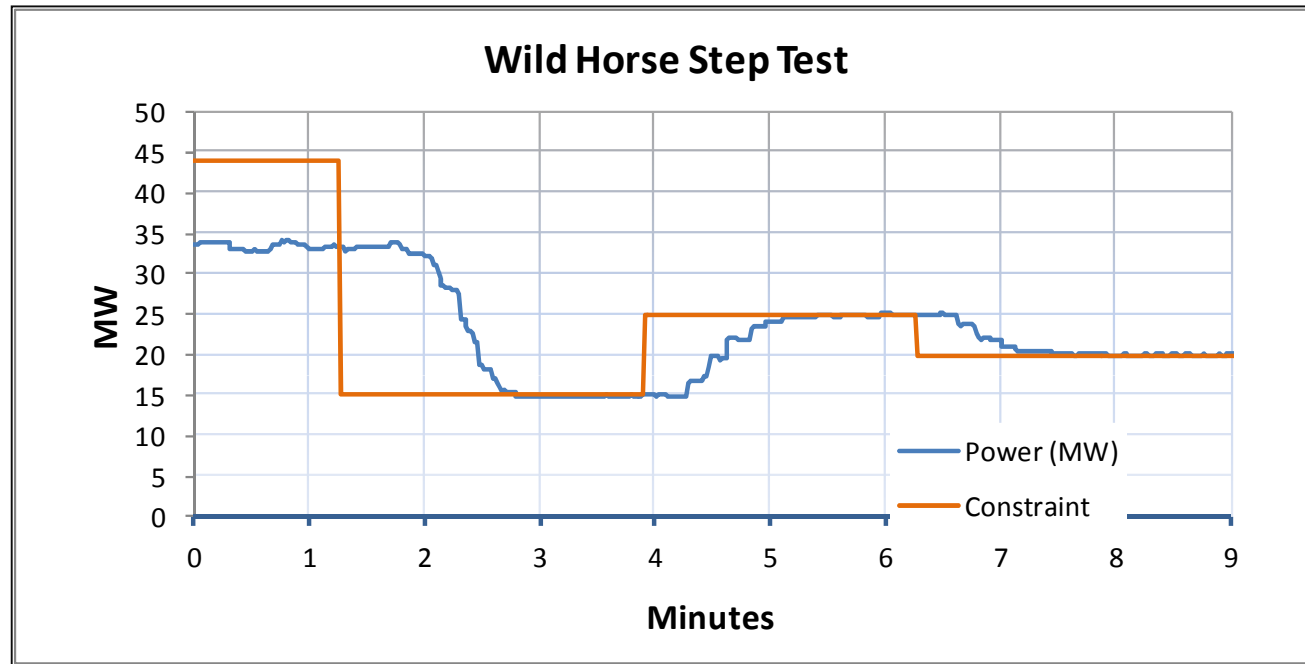Complex terrain

High wind variability

Ramp control limits

14 MW/min up ramp rate

68 MW/min down ramp rate
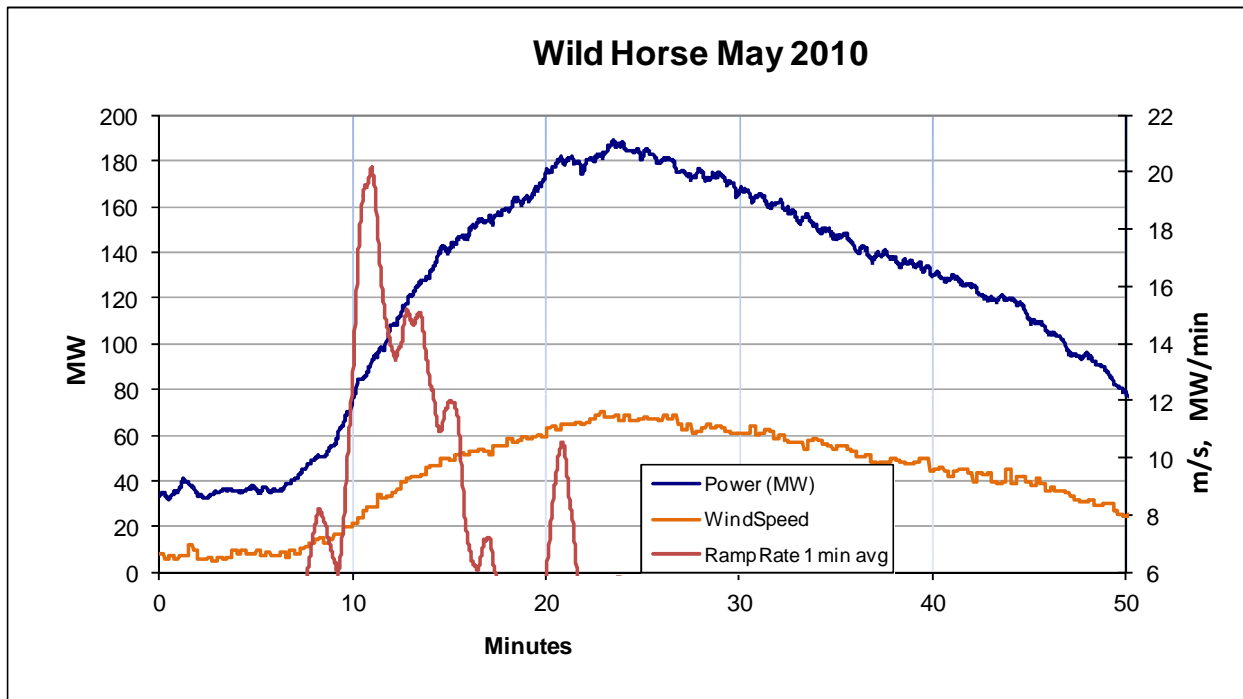
Required custom SCADA solution

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Example – Power Generation Control

Wild Horse Step Test

Power limit and rate-of-change control

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Example – Power Generation Control

Wild Horse May 2010

Response to natural wind variation

Power is proportional to cube of the wind speed

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Example – Hopkins Ridge

87 Turbines – 157 MW

Quasi-dynamic pf control

Weak 115 kV grid

Tap-changers and cap banks

Plant-wide power control
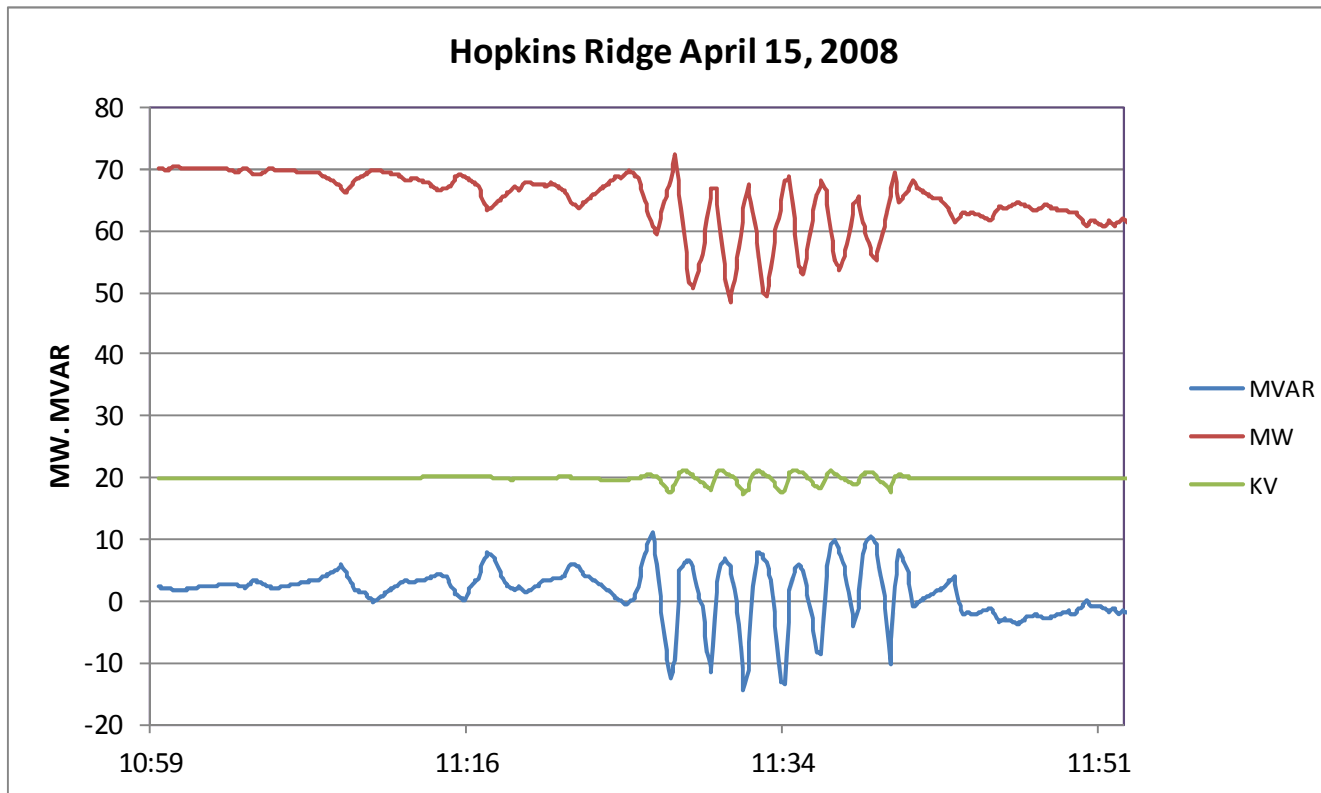
System oscillations
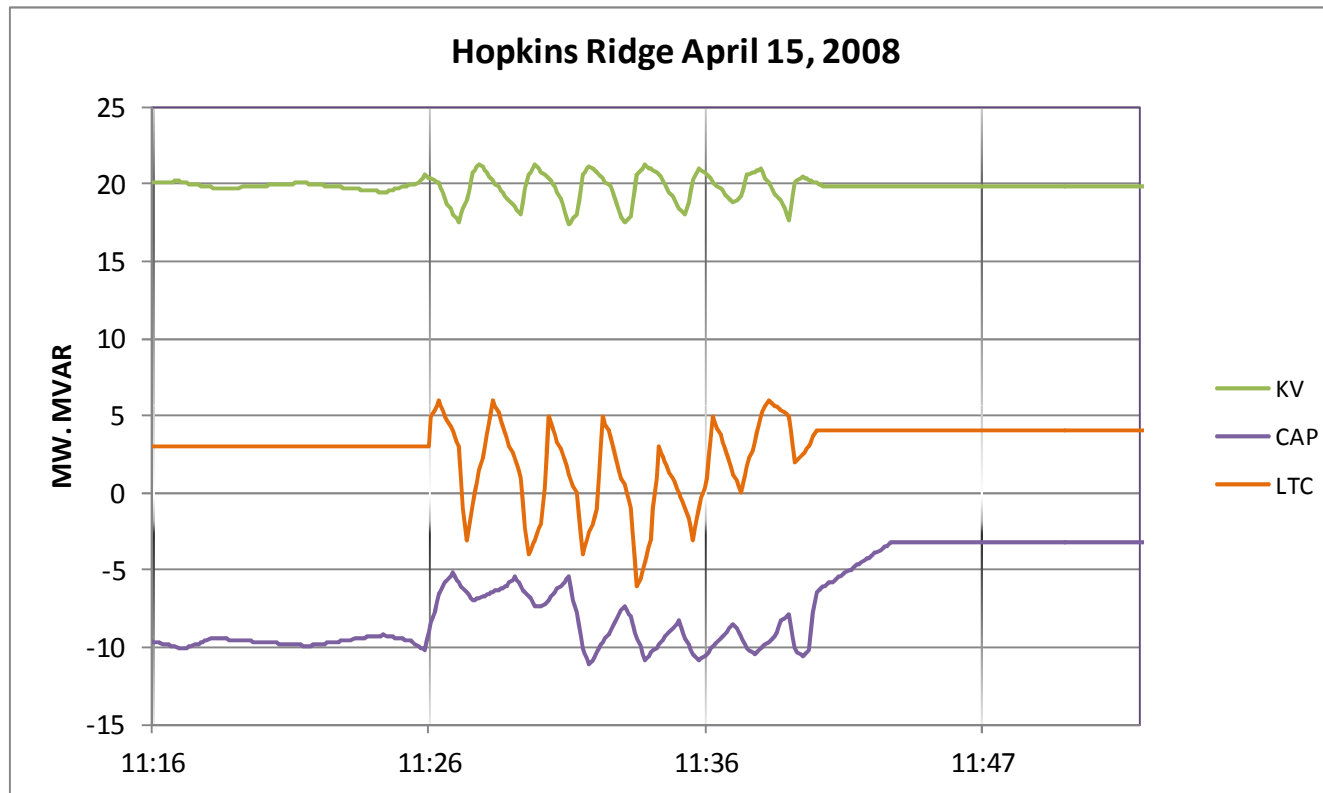

Required DVAR installation

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Example – Reactive Power Control

Hopkins Ridge April 15, 2008

Large variation in power and voltage

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Example – Reactive Power Control

Hopkins Ridge April 15, 2008

Discrete components with latency set up oscillations

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Example – Lower Snake River

149 Turbines – 343 MW

Strong 240kV grid

Plant-wide power control

Type 4 turbine

Dynamic VAR control
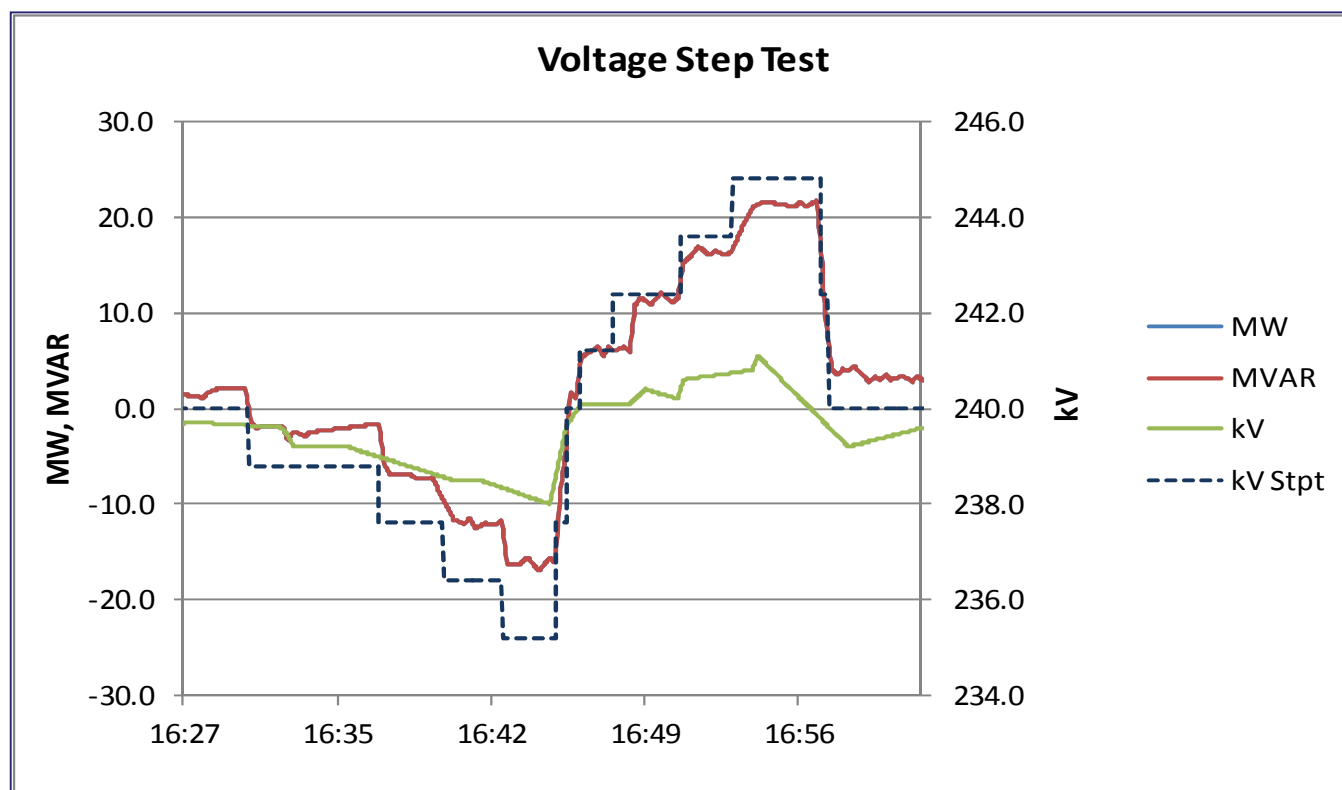
Fast response

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Example – Real Power Control

LSR Park Pilot test 2-18-2012
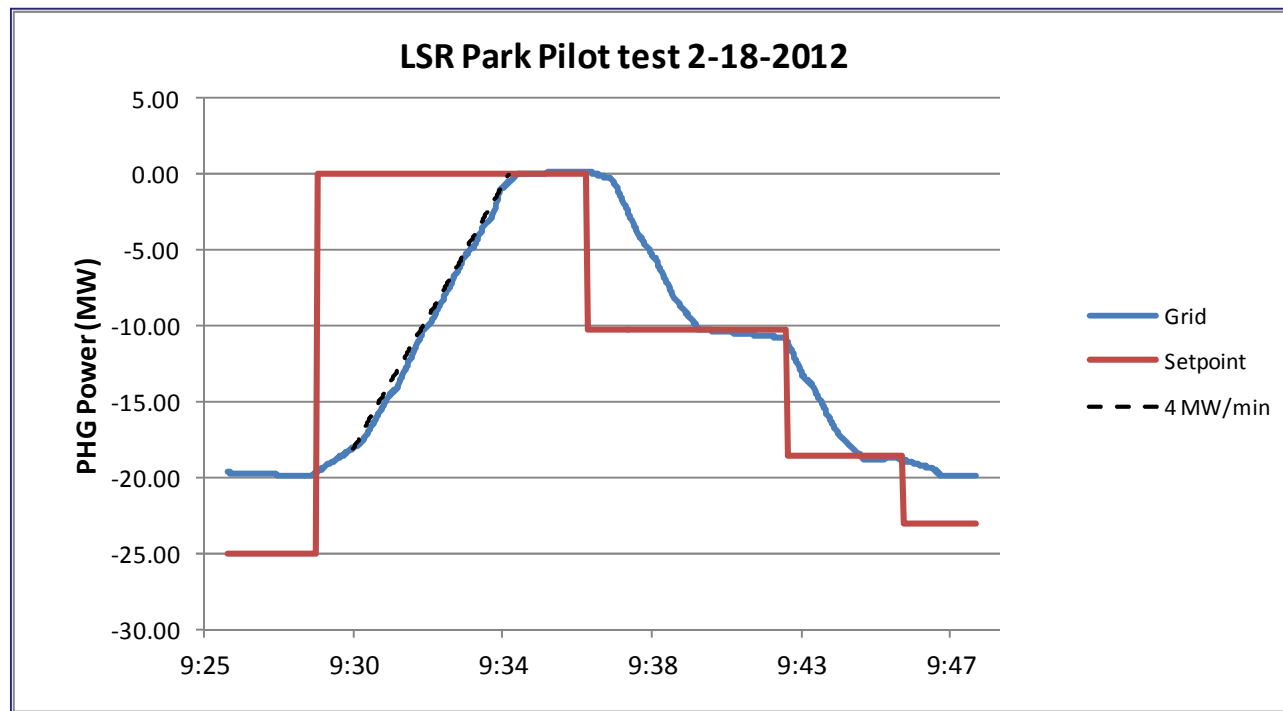
Fast turbine response and fast update rate

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Example – Voltage Control

Reactive power production to support voltage

Looking Forward

Forecasted ramp control

Spinning reserve

Grid support

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