One-Cycle Control, Inc.

The Art of Power Processing

DOE Reactive Power Supply Inverter (RPSI) for Distributed Energy

[APEC SP1.5.2 -- Mar 10, 2011]

DOE Contract: DE-FG02-07ER84692

Gregory T. Smedley, Ph.D.
CEO/President

Presentation Overview

I. One-Cycle Control, Inc.
II. The Grid & Reactive Power
III. OCC-RPSI
IV. Deployment

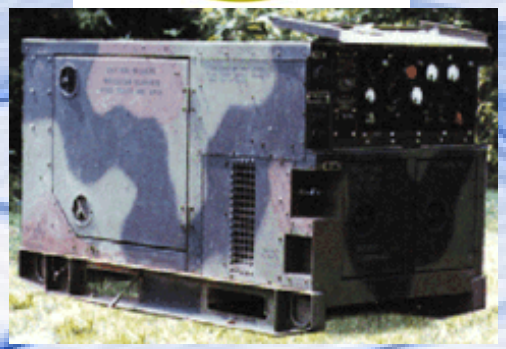
I. One-Cycle Control, Inc.

OCC Government Customers:

DOD

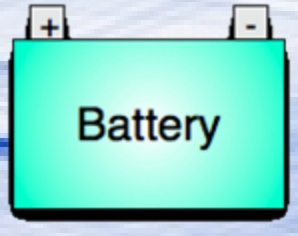
CEC

DOE



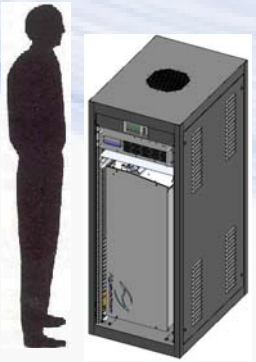
Mobile Electric Power

Power Quality



Peak Reduction

Grid Support



2010 Army Achievement Award

OCC enters Pentagon -- May 24, 2010

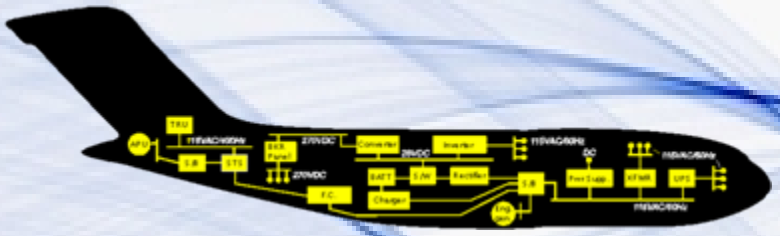
23 kg

OCC Industry Customers

- **Industry:** Utility, Aerospace, Alternative Energy, Advanced Transportation

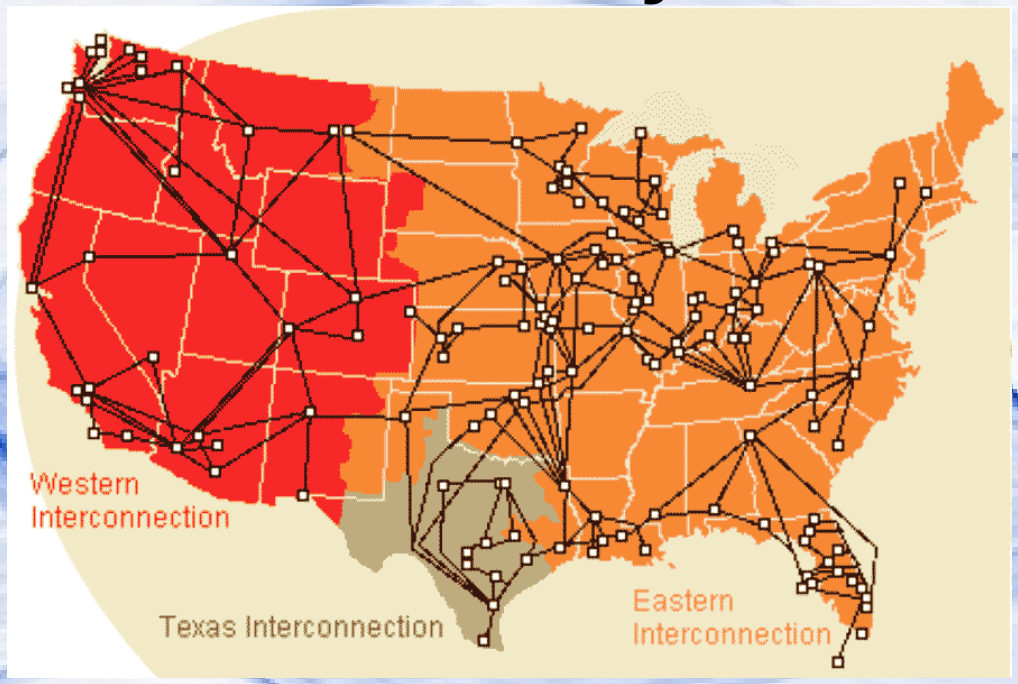
Palm Springs

~270 kg 240 kW



II. The Grid & Reactive Power

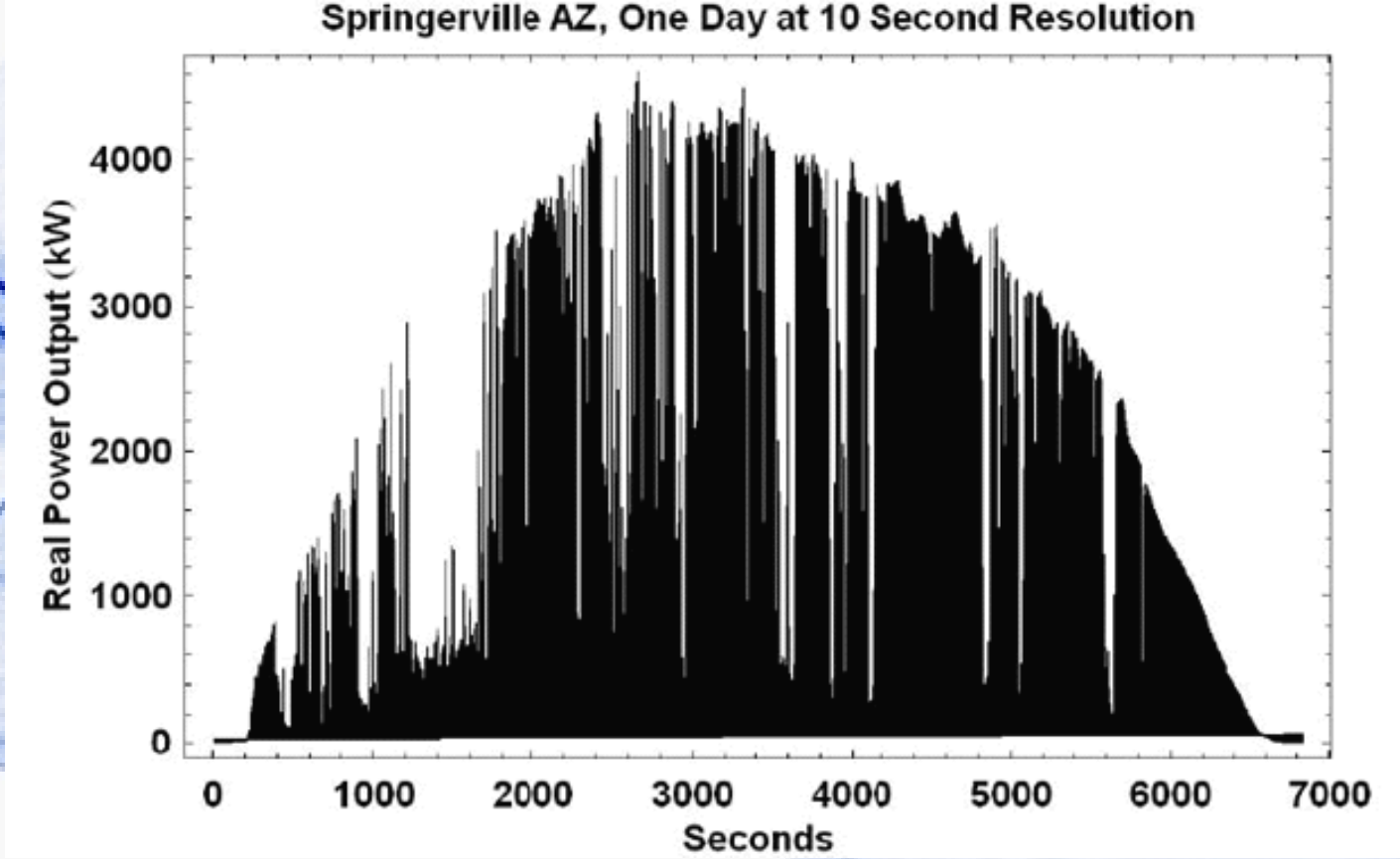
II.1 The Grid: Passive System



Source: DER, NERC EIA, Office of Coal, Nuclear, Electric, & Alt. Fuels

- **~700,000 miles T&D Lines**
- **Robust when lightly loaded**
- **Delicate when heavily loaded**
- **Complicated by increased Renewable / DER**

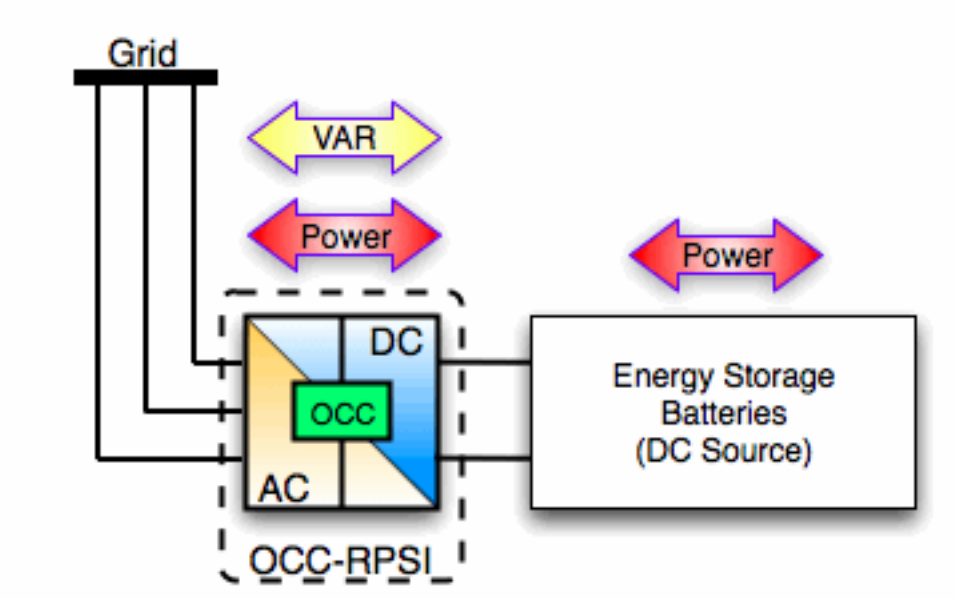
II.2 Renewable Intermittency



Source: *CEIC-08-04: "The Spectrum of Power from Utility-Scale Wind Farms and Solar Photovoltaic Arrays" Jay Apt and Aimee Curtright*

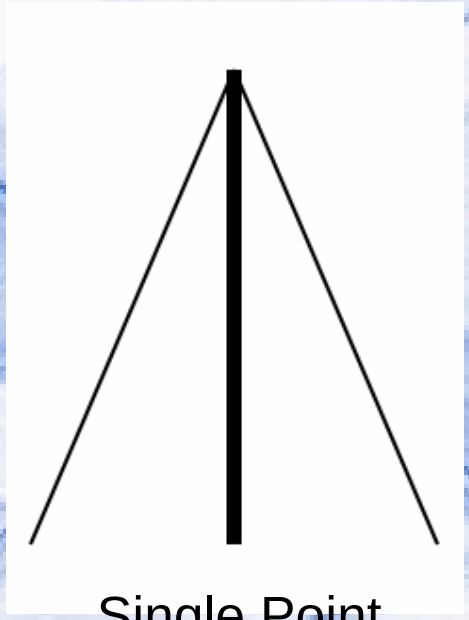
- **Dynamic Sources ==> Dynamic Grid Voltage/Frequency**

II.3 OCC-RPSI Benefits

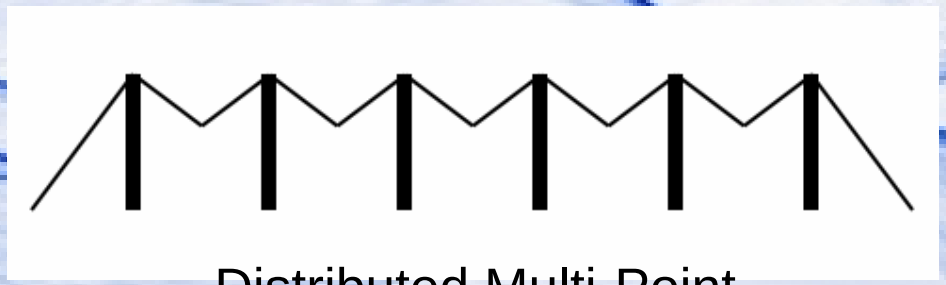


- **Real Power ==> Rapid Frequency Stabilization**
- **Reactive Power ==> Rapid Voltage Stabilization**
- **Power Flow Control**
- **Extend margin to voltage collapse**
- **Enable Increased Renewable/DER Penetration**

II.4 Distributed Multi-Point OCC-RPSI



Single Point



Distributed Multi-Point

- **Widely distributed Voltage & Freq support/stabilization**
- **Autonomous dynamically controlled voltage profile**
  - Improved Grid Stability
  - Increased renewables (DER) penetration
  - Decreased “central-control” burden

III. OCC-RPSI

DOE Program @ OCC

DOE Contract: DE-FG02-07ER84692

gsmedley@onecyclecontrol.com

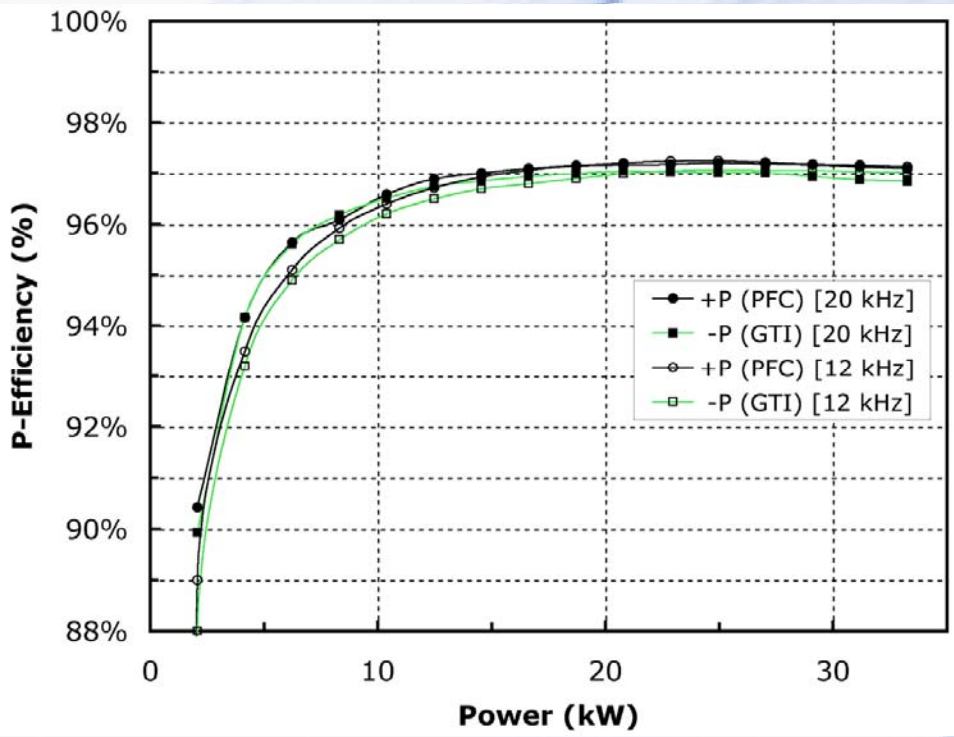
III.1 Three-Phase OCC-RPSI

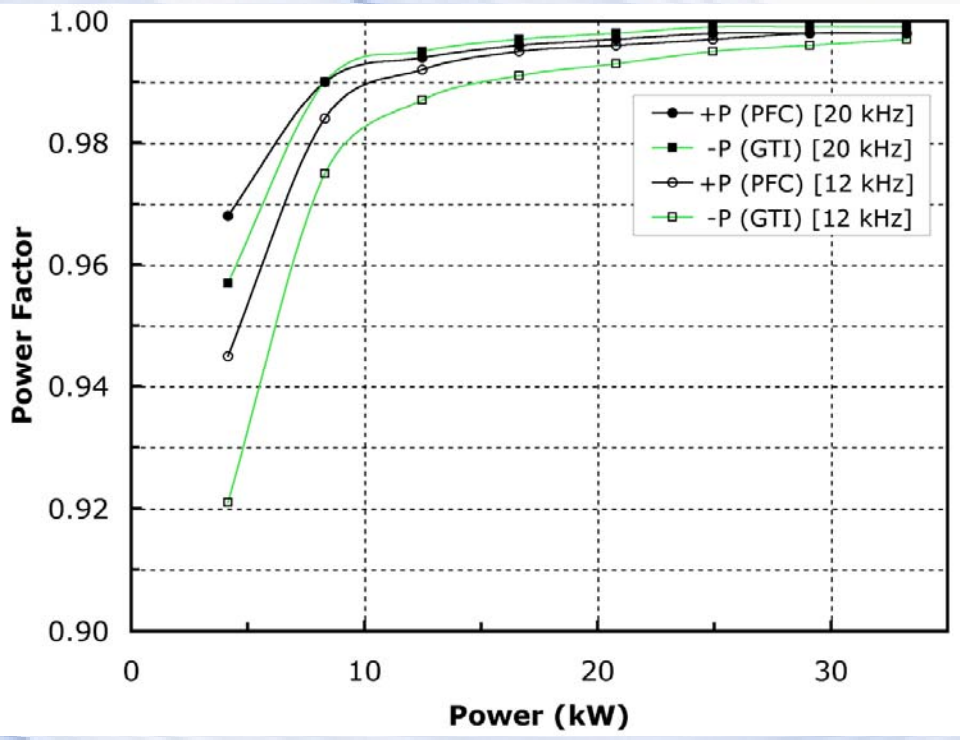
"Commercial-Inverter" based
{12kHz, 42A @ 480Vac}

"Pure-OCC" based
{20kHz, 50A @ 480Vac}

- Full 4-Quadrant
- High Performance & High Efficiency
- Rapid Dynamic Real/Reactive Power
- Smooth variable control

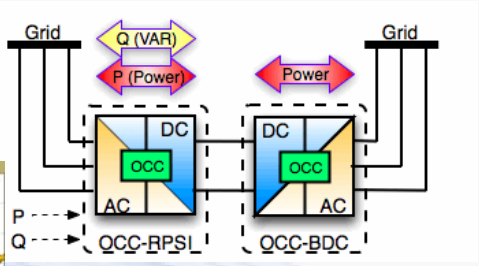
III.2 OCC-RPSI Efficiency & Power Factor

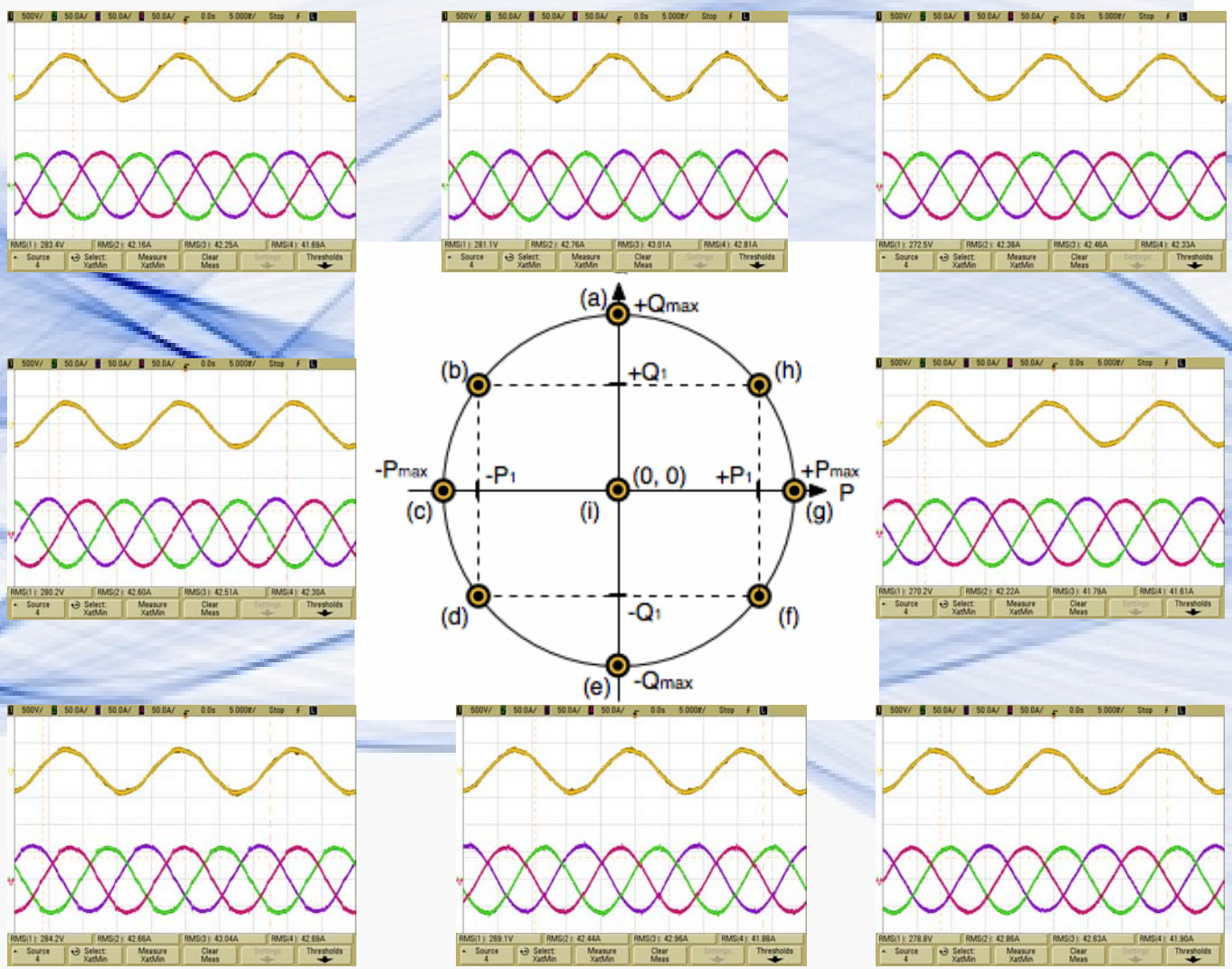




- High Efficiency & Power Factor

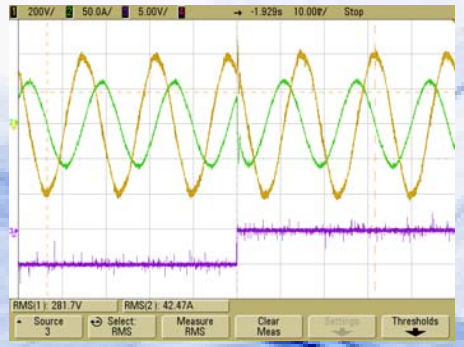
III.3 OCC-RPSI Steady State

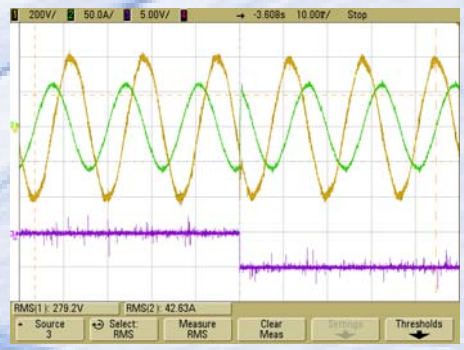


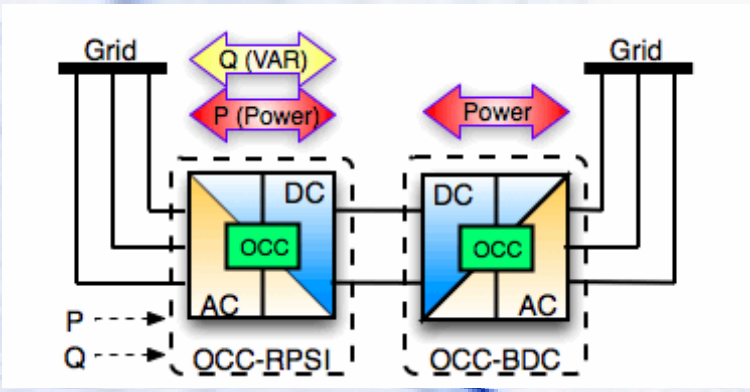


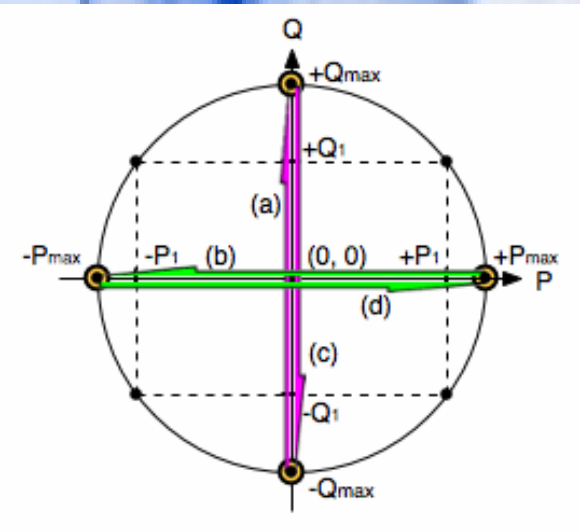
- Clean High-Quality Performance

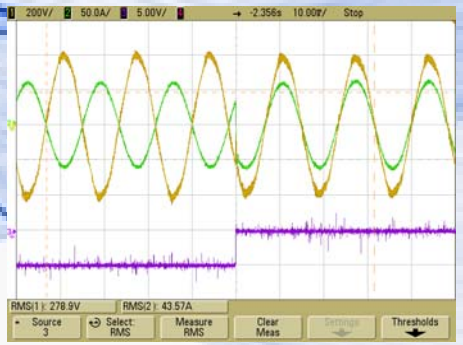
III.4 OCC-RPSI Dynamic Transitions

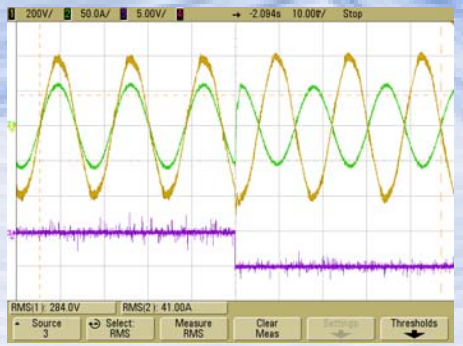












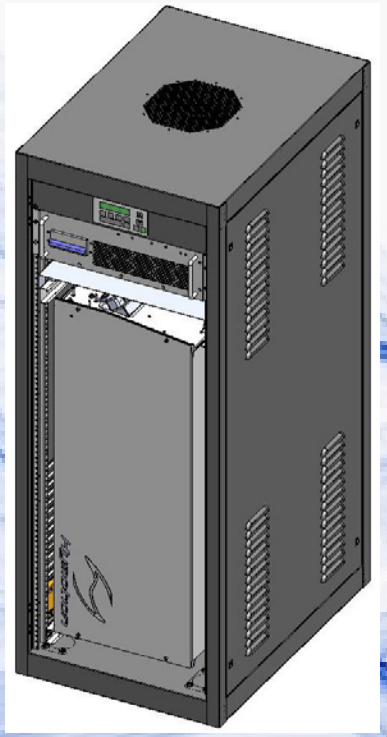
- Precise Rapid Transitions {~50 usec}
- Anywhere within PQ circle

IV. Deployment

IV. Deployment

Solo OCC-RPSI

Rackable RPSI
e.g. 240 kVAR



OCC-RPSI with
Energy Storage

- **Widely Distributed "Reflexes"**
  - Improved Grid efficiency & Power Quality
  - Improved Grid Stability
  - Increased DER Penetration
  - Distributed Intelligence / Autonomy

Greg Smedley

Thank you for your attention … Questions ??

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