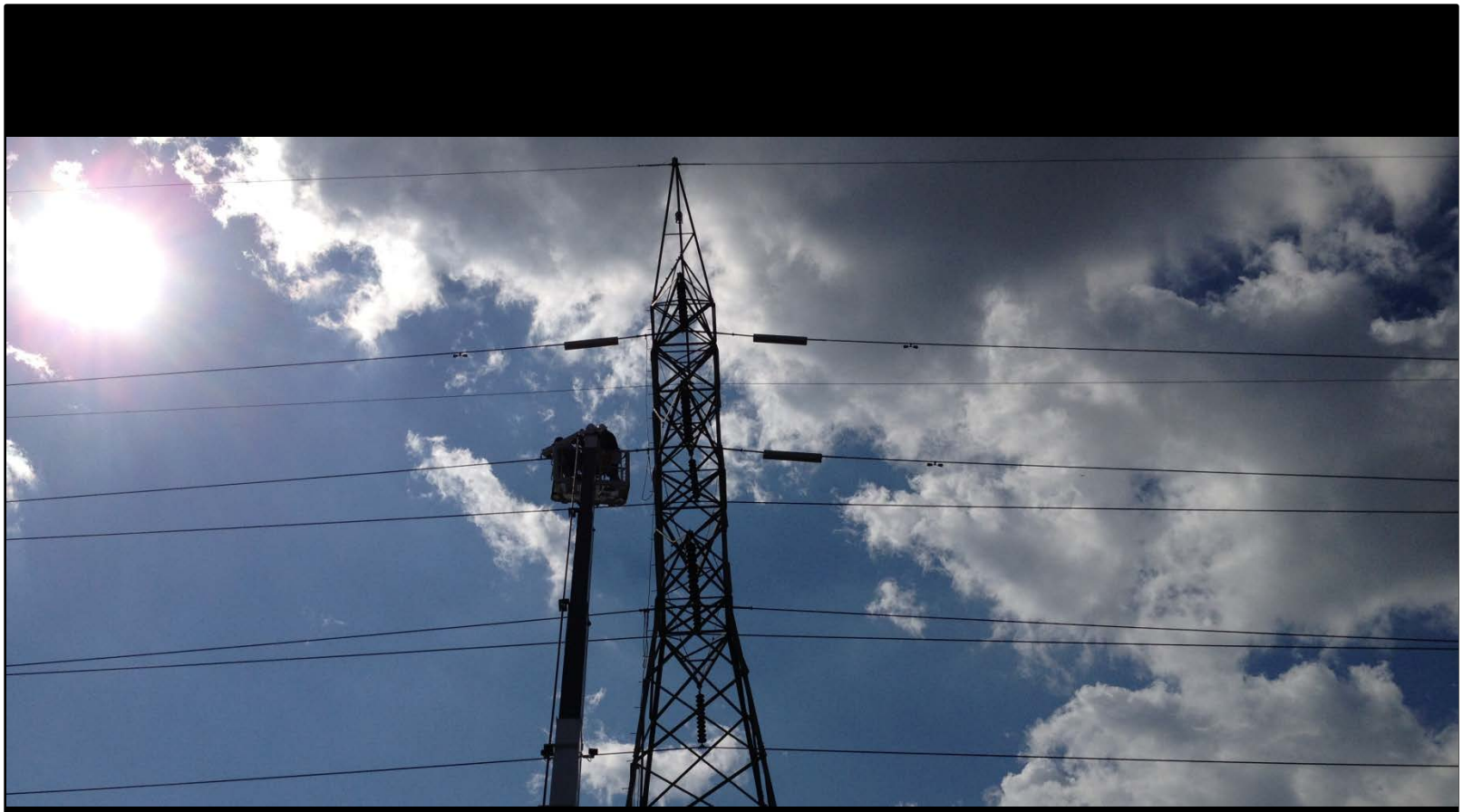
D-FACTS & Smart Wire Technology



Andrija Sadikovic
Smart Wire Grid, Inc.
January 22, 2013

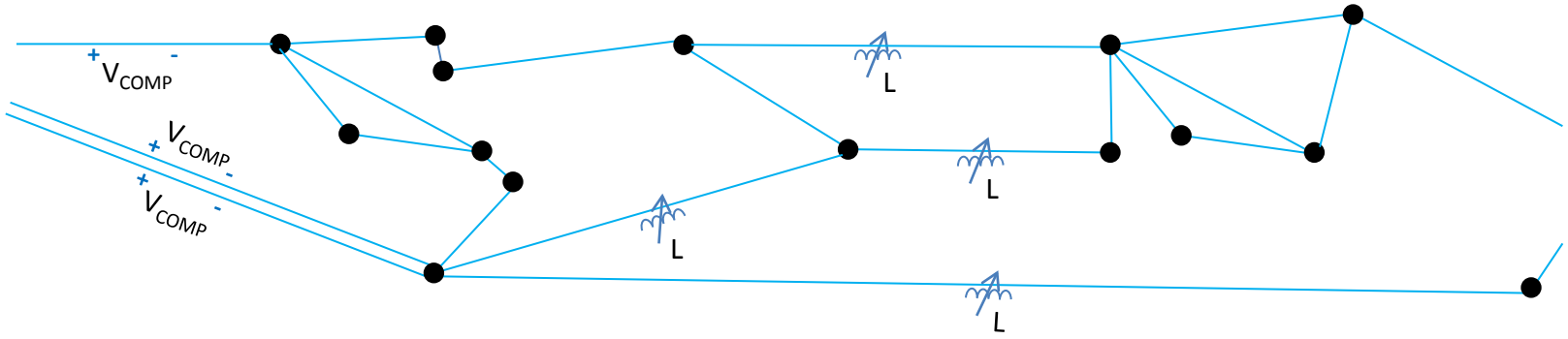
Power flow control for the Grid

Smart Wire Technology

Flexible

transmission system

operation **configuration**



Applications:

overload protection, **congestion** relief, increase in **ATC**, participation in **RAS/SPS**, etc.

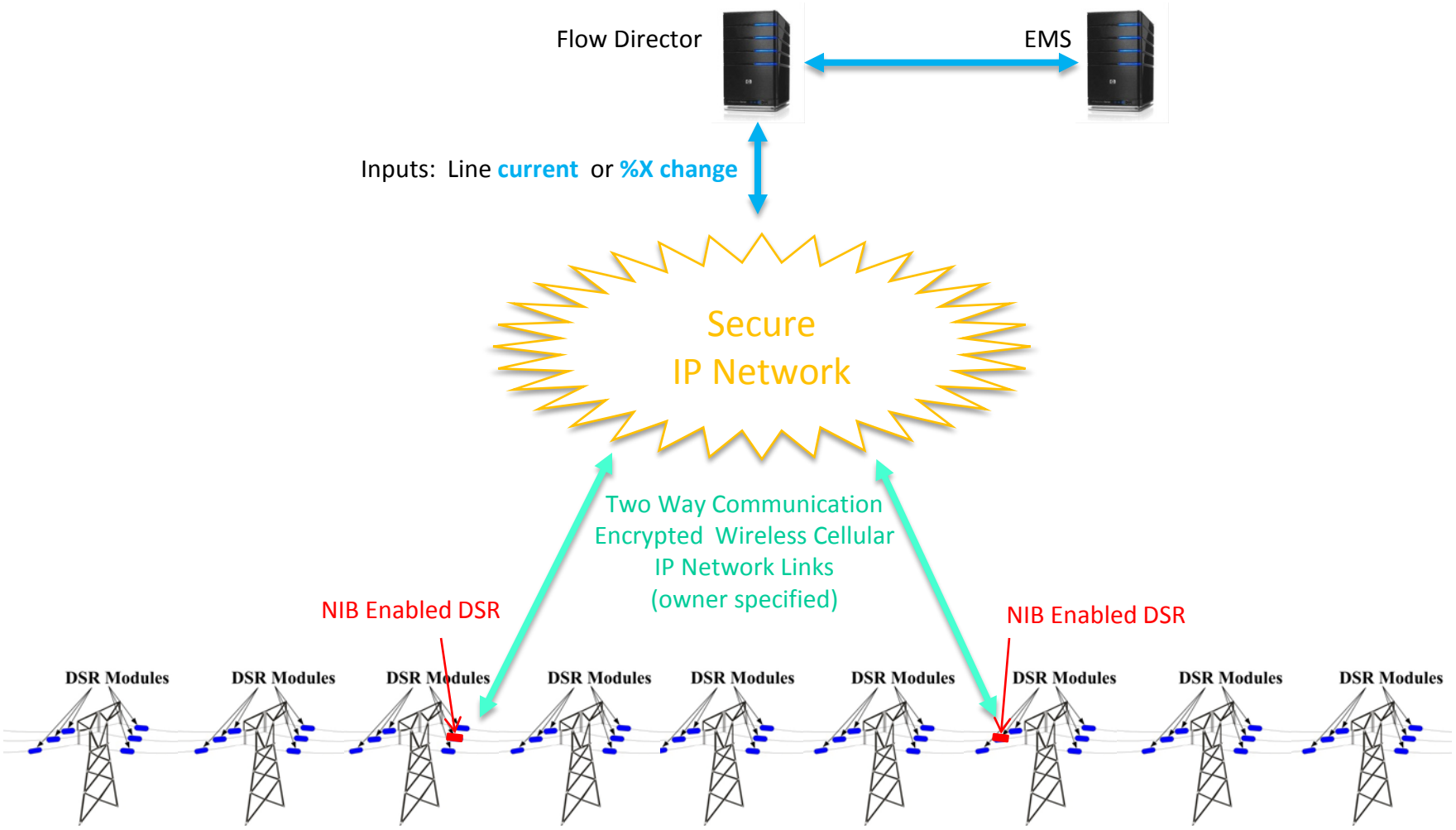
Power flow control for the Grid

Smart Wire Technology

Objective:	**Control power flow**	
Inputs:	**Line current or %X change**	
Hardware:	**Distributed Series Reactor (+L)**	*in use*
	Distributed Series Compensator (+/-L)	*in development*
	Network Interface Bridge (NIB)	*in use*
Software:	**Control Agent (resides in NIB)**	*in use*
	System Manager (standalone server based)	*in use for pilot projects*
	Flow Director (integrated with EMS)	*in development*
Results:	**Power flow control on EACH phase**	*in use*
Monitor:	**Line current, frequency, fault current**	*in use*
	Conductor temperature	*in use*
	Sag, vibration, ambient temperature	*in development*

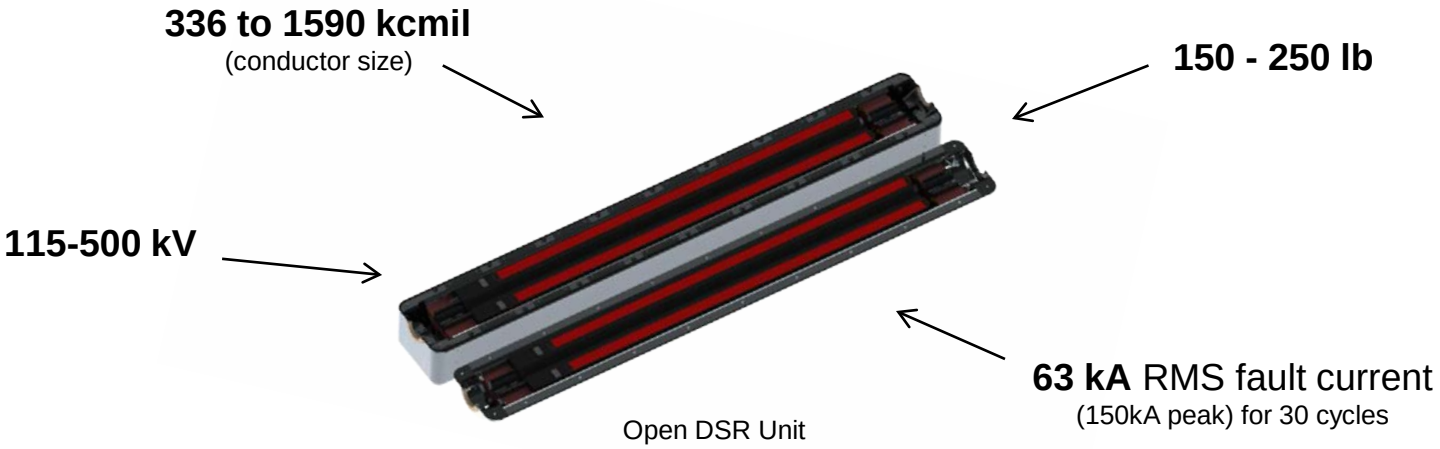
Power flow control for the Grid

Configuration Example



Power flow control for the Grid

Distributed Series Reactor (DSR)

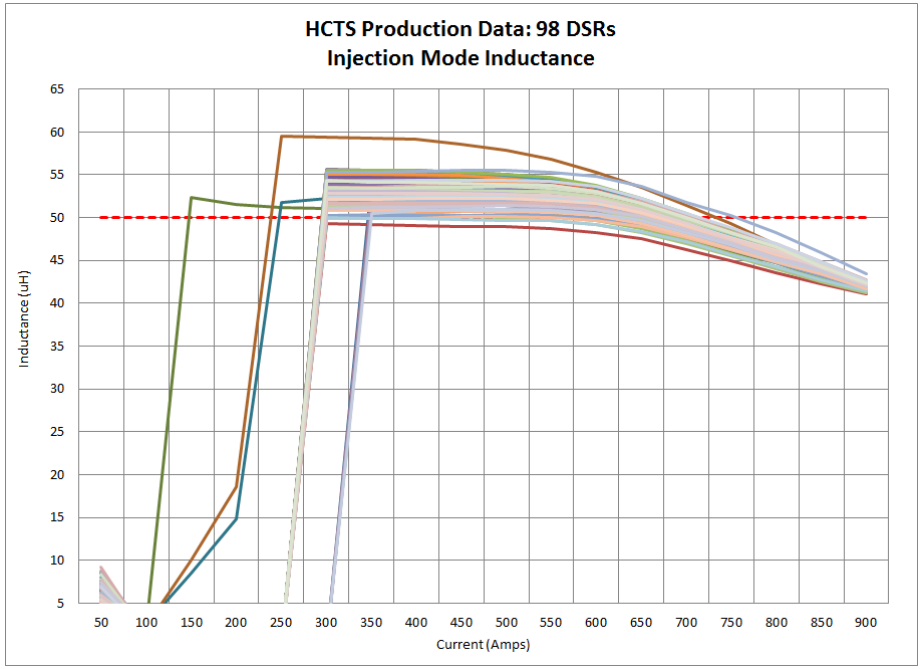


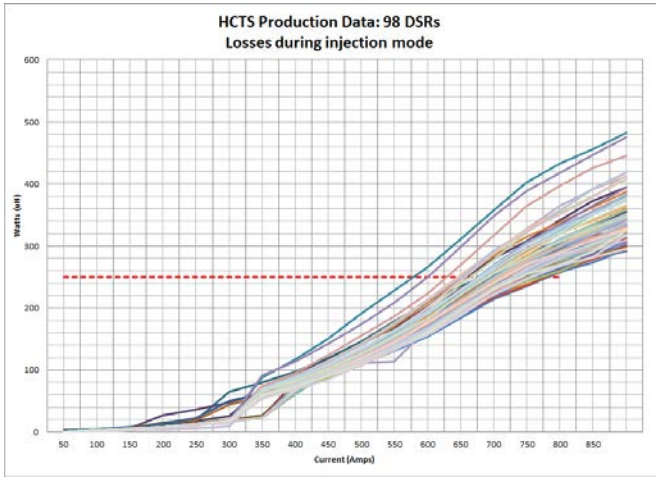
- Life: 20+ year life; zero maintenance
- Install: de-energized or live line
- Fault current: sense within 5 µs, then automatic transition from injection to monitoring mode in 5 ms.
- No corona at operating voltage
- Environmental: Resistant to - salt fog, Aeolian vibration, ice buildup, thermal cycling
- Conductor impact: No mechanical or thermal conductor degradation
- Lightning Strike: tested to line BIL
- Wind loading: up to 150 mph
- Communications: Module to ground or SCADA link as specified by owner.

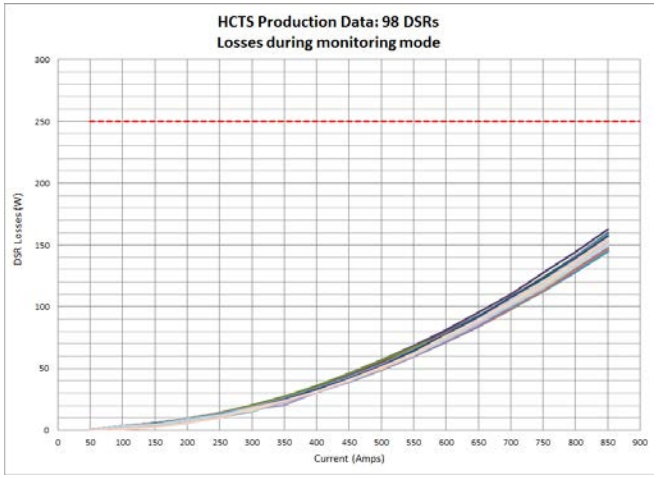
50 µH per module per mile changes typical 138 kV conductor impedance by roughly 2%

Power flow control for the Grid

DSR Characteristics 750A design



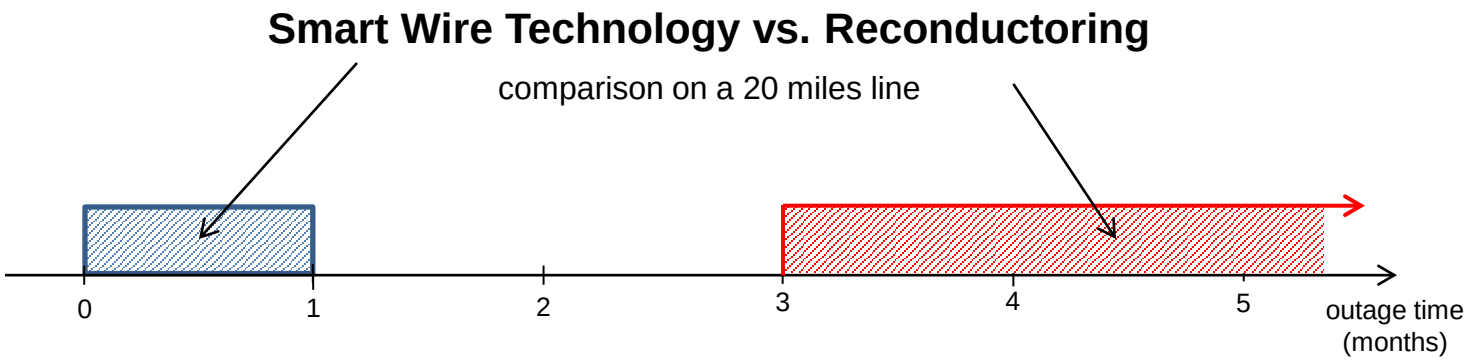




Injection mode: 50 µH per module
Monitoring mode: 1 µH per module

Power flow control for the Grid

Easy Installation & minimum outage

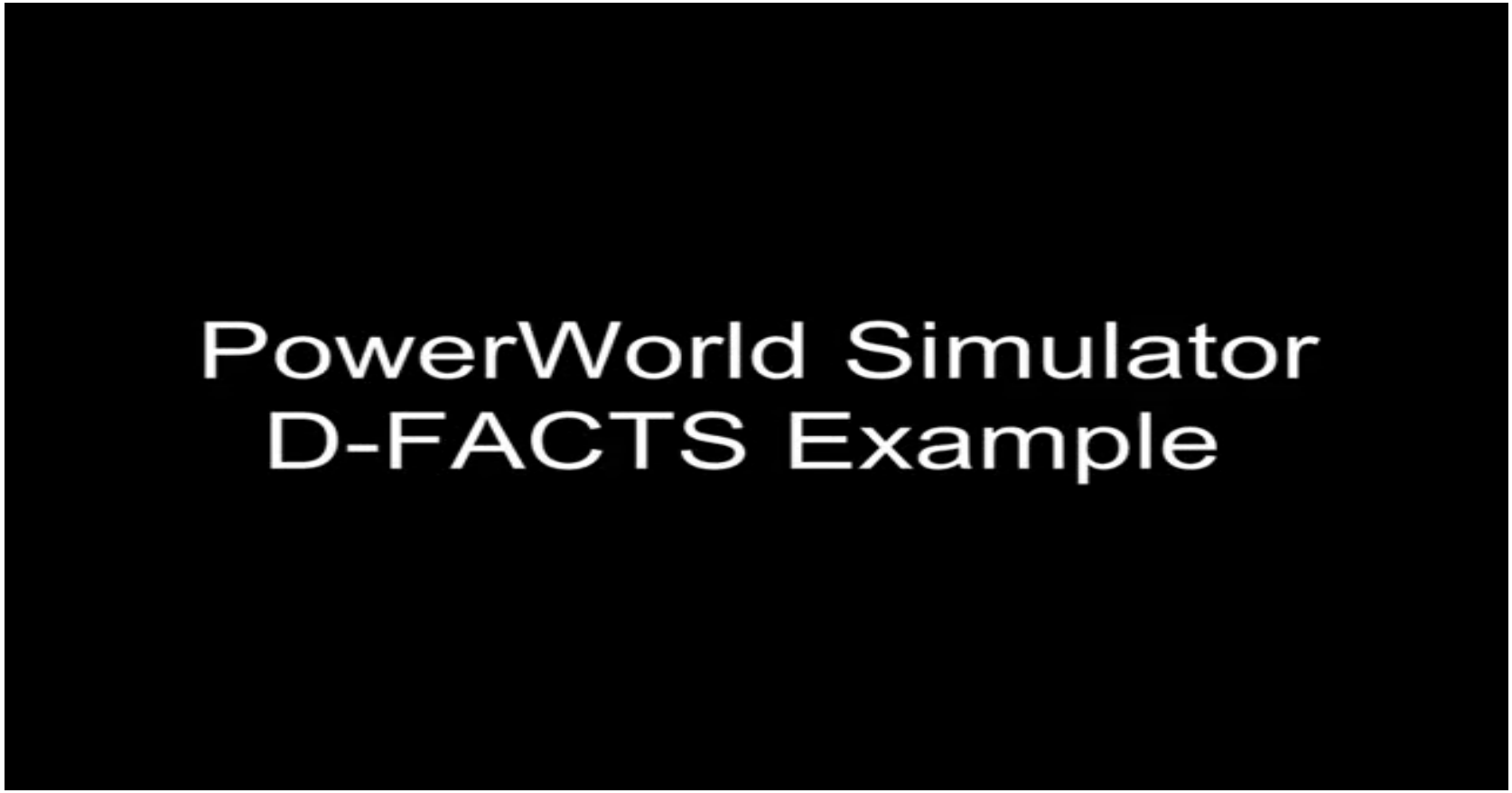


- 7 min per module
- de-energized or live line
- Self diagnostics/remote testing

TVA Lineman: "One of the easiest things I have installed…"

Power flow control for the Grid

Power World Demo

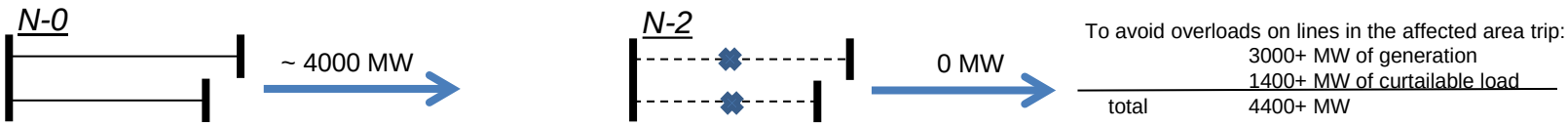


http://www.youtube.com/watch?v=nIPhUiS8rYg&feature=plcp

Power flow control for the Grid

Applications – RAS

DSRs contribution to Remedial Action Scheme (RAS)



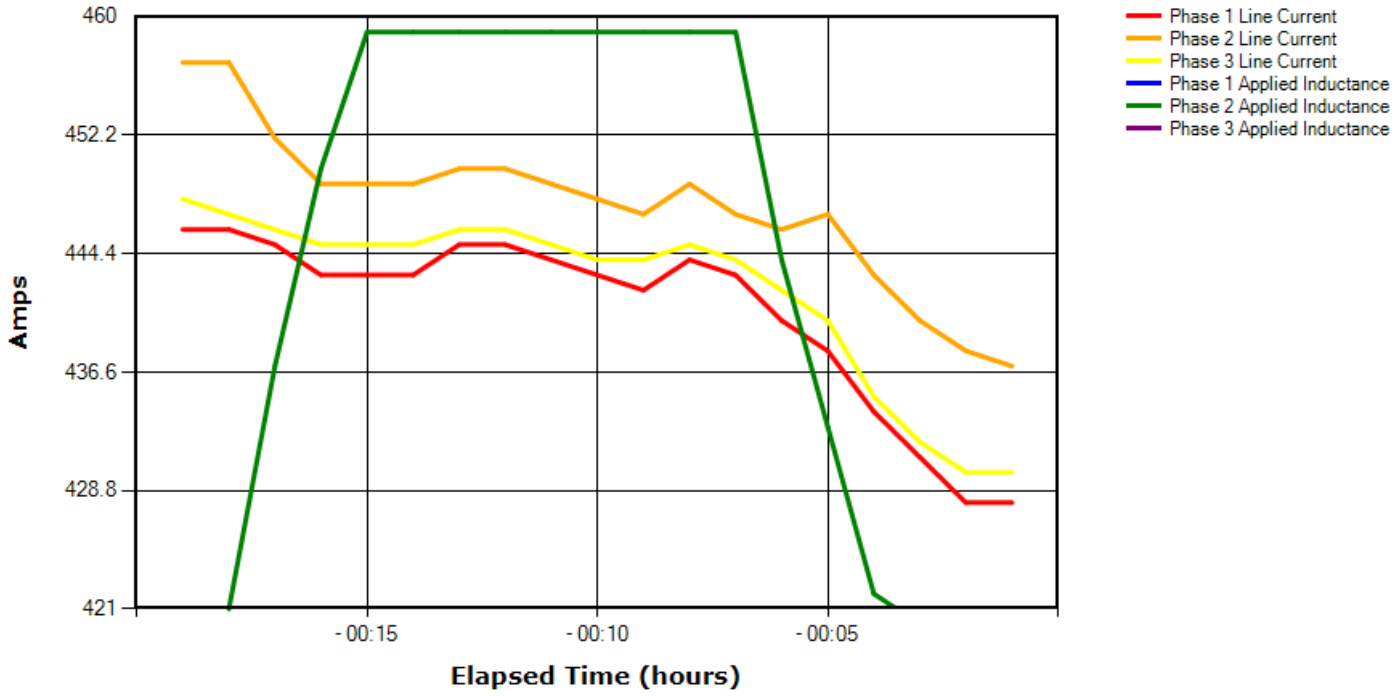
Scenario (DSR and ckt count are cumulative)	Generation Not tripped (MW)	Curtailable Load Not tripped (MW)	Total Capacity Preserved (MW)	Non-interrelated overloads (%)
1 – 111 DSRs 1 circuit	671	0	671	1.2 Total 1.2
2 – 651 DSRs 3 ckts	671	530	1201	6.4 0.6 Total 7.0
3 – 1341 DSRs 5 ckts	671	871	1542	9.9 3.4 Total 14.5
4 – 2013 DSRs 9 ckts	671	1039	1710	0.6 11.4 9.9 4.6 Total 26.5

Power flow control for the Grid

Applications – Phase Balancing

Pilot program phase balancing results

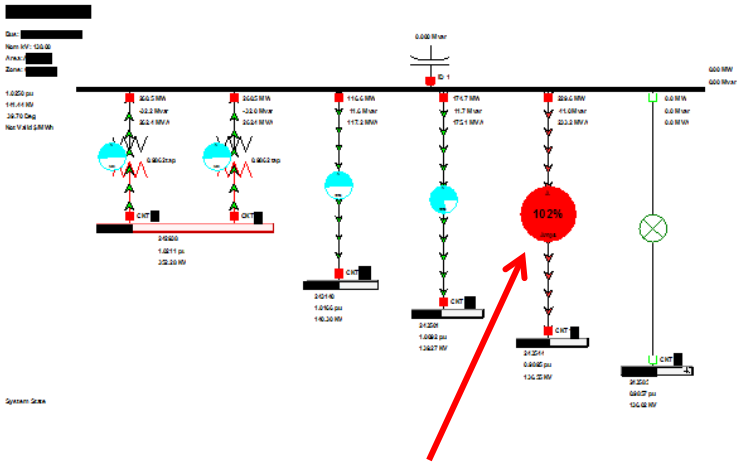
3% impedance change on phase 2



Power flow control for the Grid

Applications – N-1 overload (congestion)

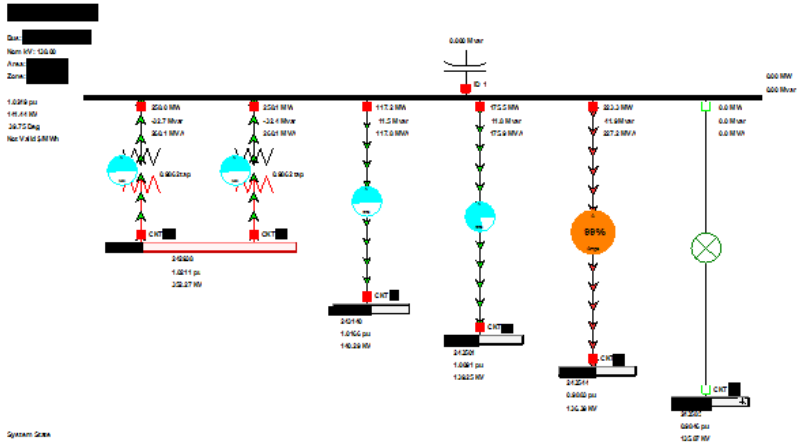
w/o DSRs



Congestion issue: off cost re-dispatch

with DSRs

10% change in X (60 modules per phase)



Power flow control for the Grid

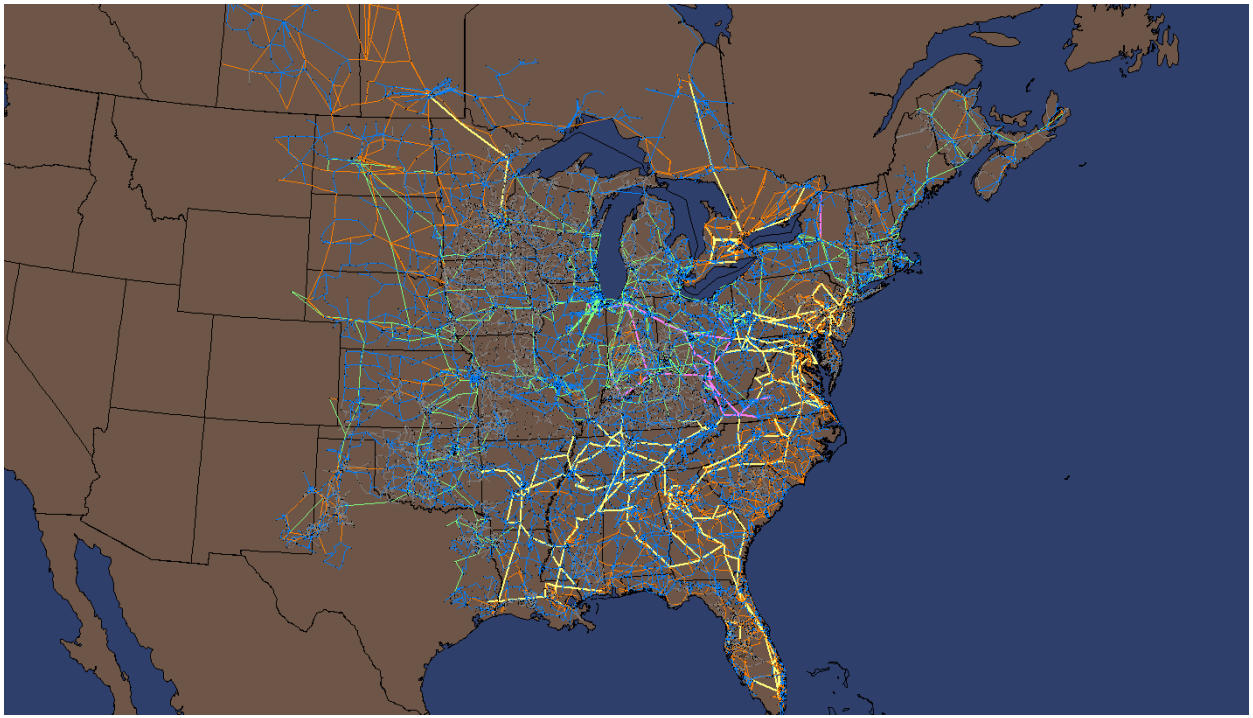
Applications – OPF in Power World

Exercise: **2012 summer peak planning case** *(not an operational case)*

Focus: **East coast RTO area with total of 3000 modules placed on 6 lines**

OPF Solution: **1.4% reduction in Final Total Cost Value**

6.1% reduction in Average Bus Marginal Cost



TBD: **To which extent the Smart Wire Technology can reduce energy cost…**

Power flow control for the Grid

Questions?

Contact Info:

Andrija Sadikovic

andrija.sadikovic@smartwiregrid.com
+1 510 267 4323

Smart Wire Grid, Inc.
1300 Clay Street, Suite 840
Oakland, CA 94612-1428
United States of America