New Control of PV Solar Farm as STATCOM (PV-STATCOM) for Increasing Grid Power Transmission Limits During Night and Day

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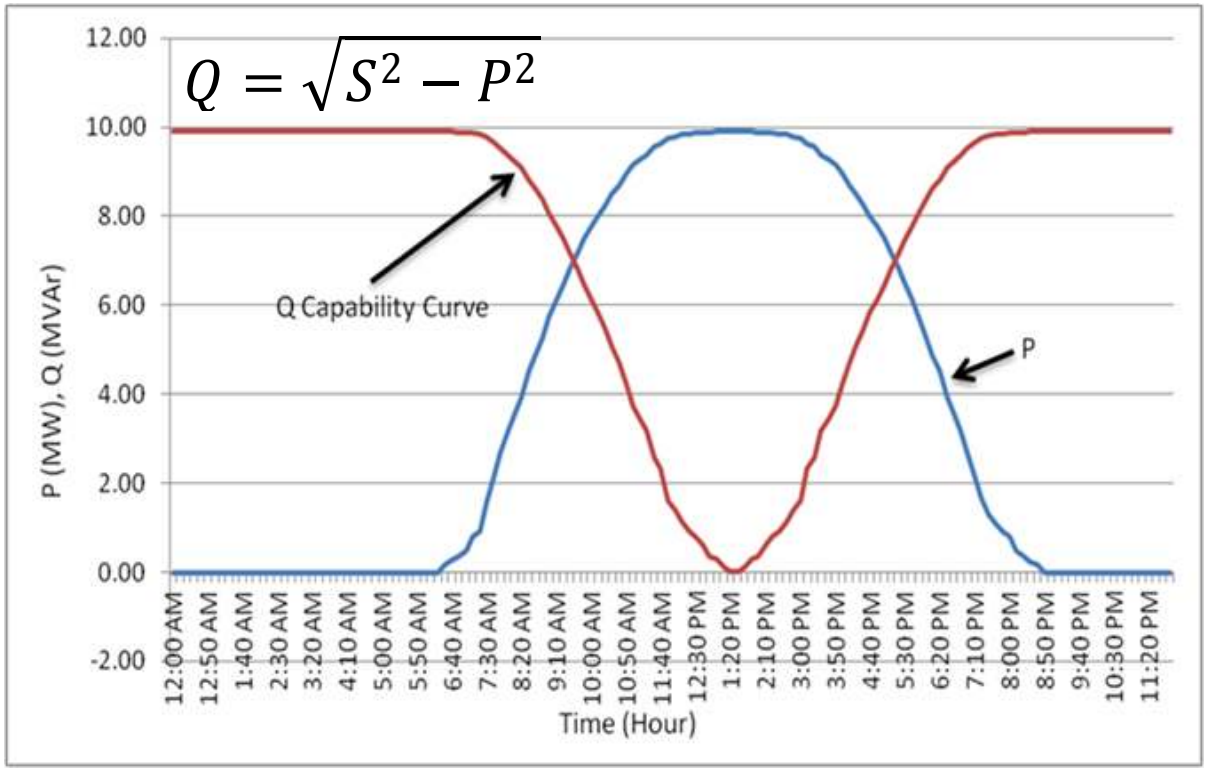
Novel Concept

Utilization of PV Solar Farm in Night and Day as STATCOM!

Termed as PV-STATCOM

patent pending

Concept of Control: PV Solar Farm Inverter as STATCOM



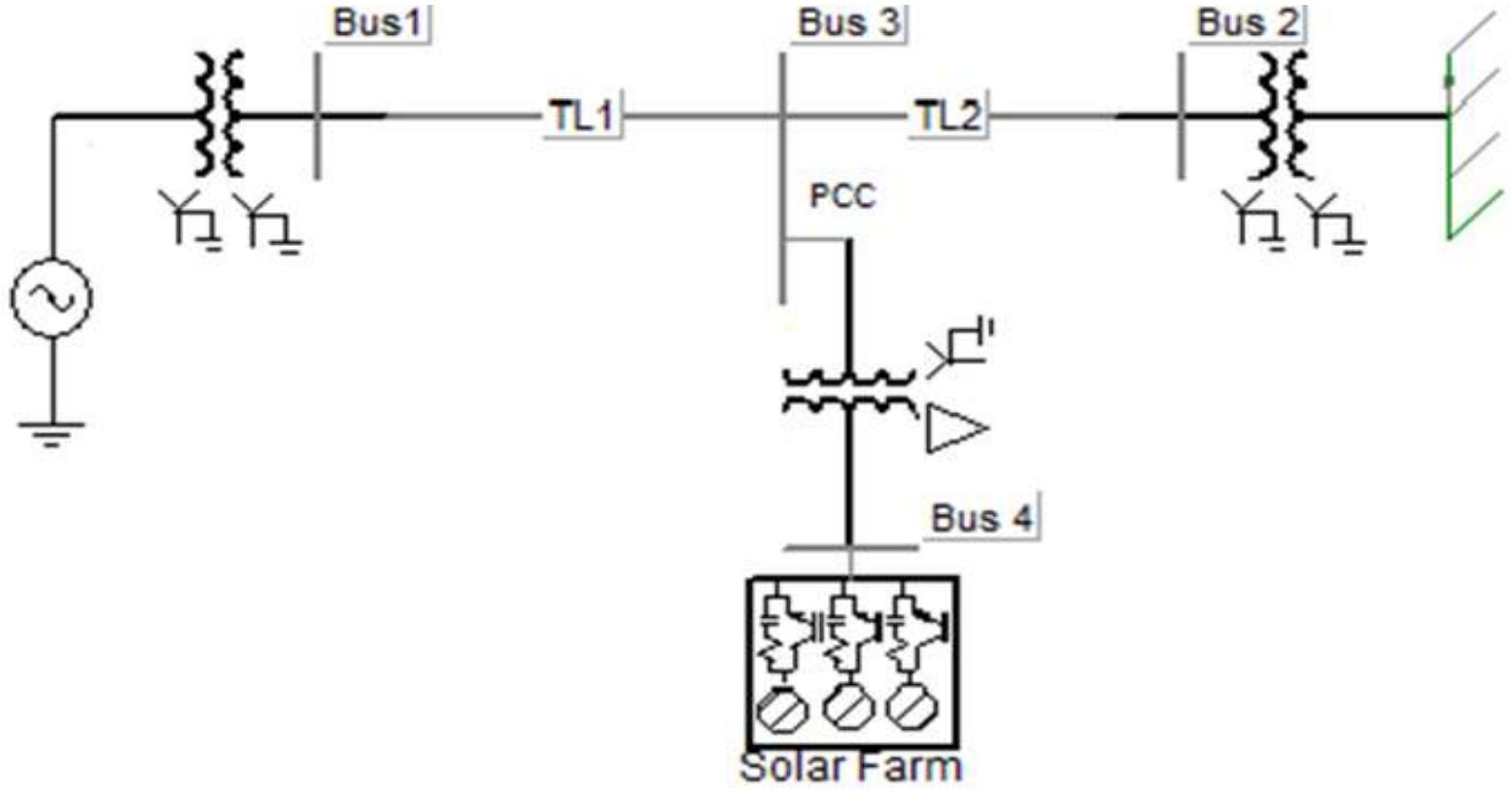
Nighttime: Entire Inverter Capacity Utilized for STATCOM

Daytime: Remaining Inverter Capacity Utilized for STATCOM

Transmission Challenges

- Power transmission capacity of lines typically limited
- Constraints on adding new generation, e.g. wind power system.
- Potential Solutions:
  - Construct new lines ~ $500 Million (for 200 km)
  - Install SVC/STATCOM ~ $50 Million
  - Proposed PV-STATCOM control ~$ 200k

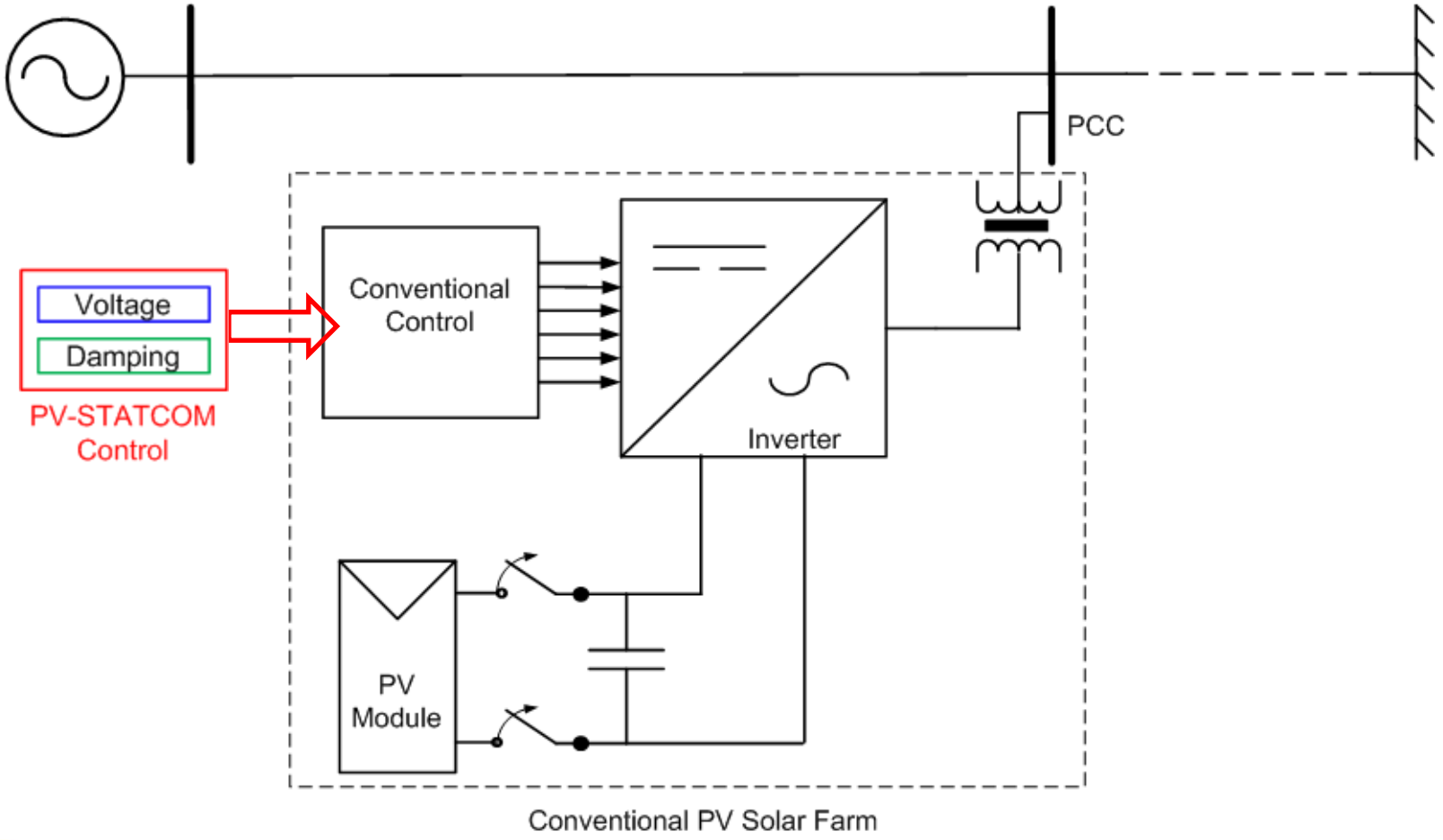
Study System - 1



Single Machine Infinite Bus (SMIB) System with

100 MW solar farm on a 200 km line

PV Solar Farm as STATCOM



Study Considerations

- Three phase to ground fault for 6 cycles at generator bus.
- Damping controller : lead-lag compensator.
- Damping signal : Line current at inverter output.
- Damping ratio: 5%.
- PCC voltage overshoot not to exceed 1.1 p.u.

SMIB System with One Solar Farm

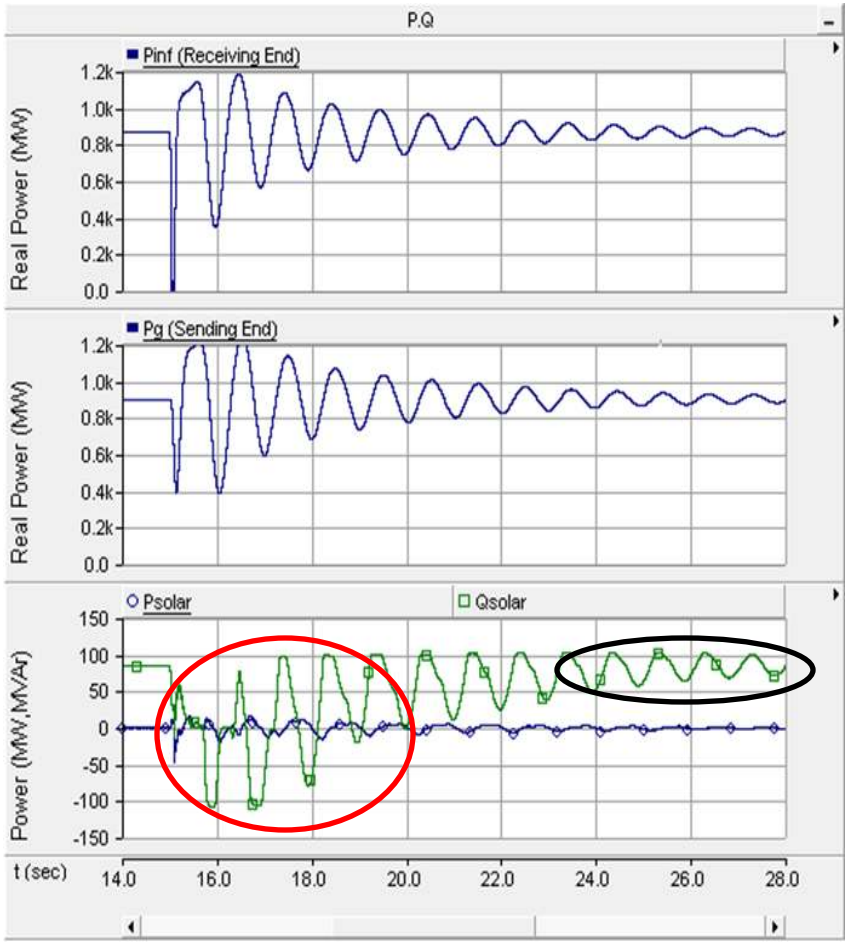
Maximum power transfer with conventional PV system

Night	P_{PV}=0 MW	**731 MW**
Day	P_{PV}=19MW	**730 MW**
	P_{PV}=91MW	**719 MW**

Power transfer improvement with PV-STATCOM

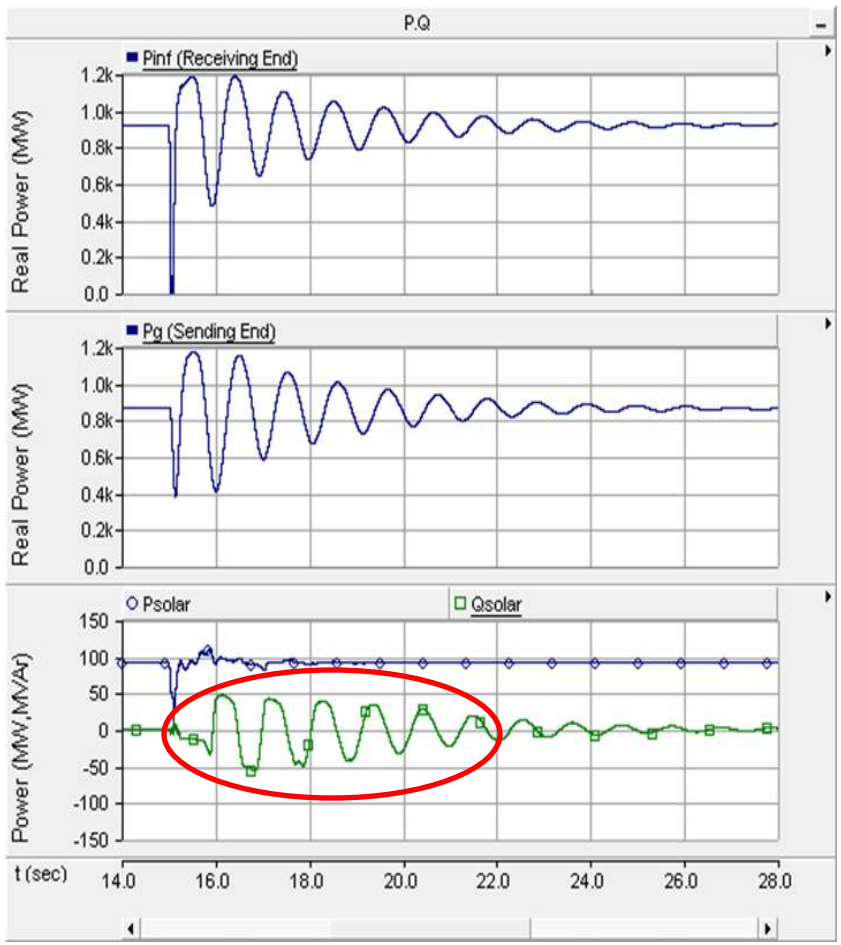
PV-STATCOM Control	Nighttime Power Limit Gain (MW)	Daytime Power Limit Gain (MW)	
		Solar DG Power output 19MW	Solar DG Power output 91MW
Voltage control	102	85	7
Damping Control	119	121	**142**
Voltage control with damping control	**168**	93	36

SMIB System with One Solar Farm



Night time

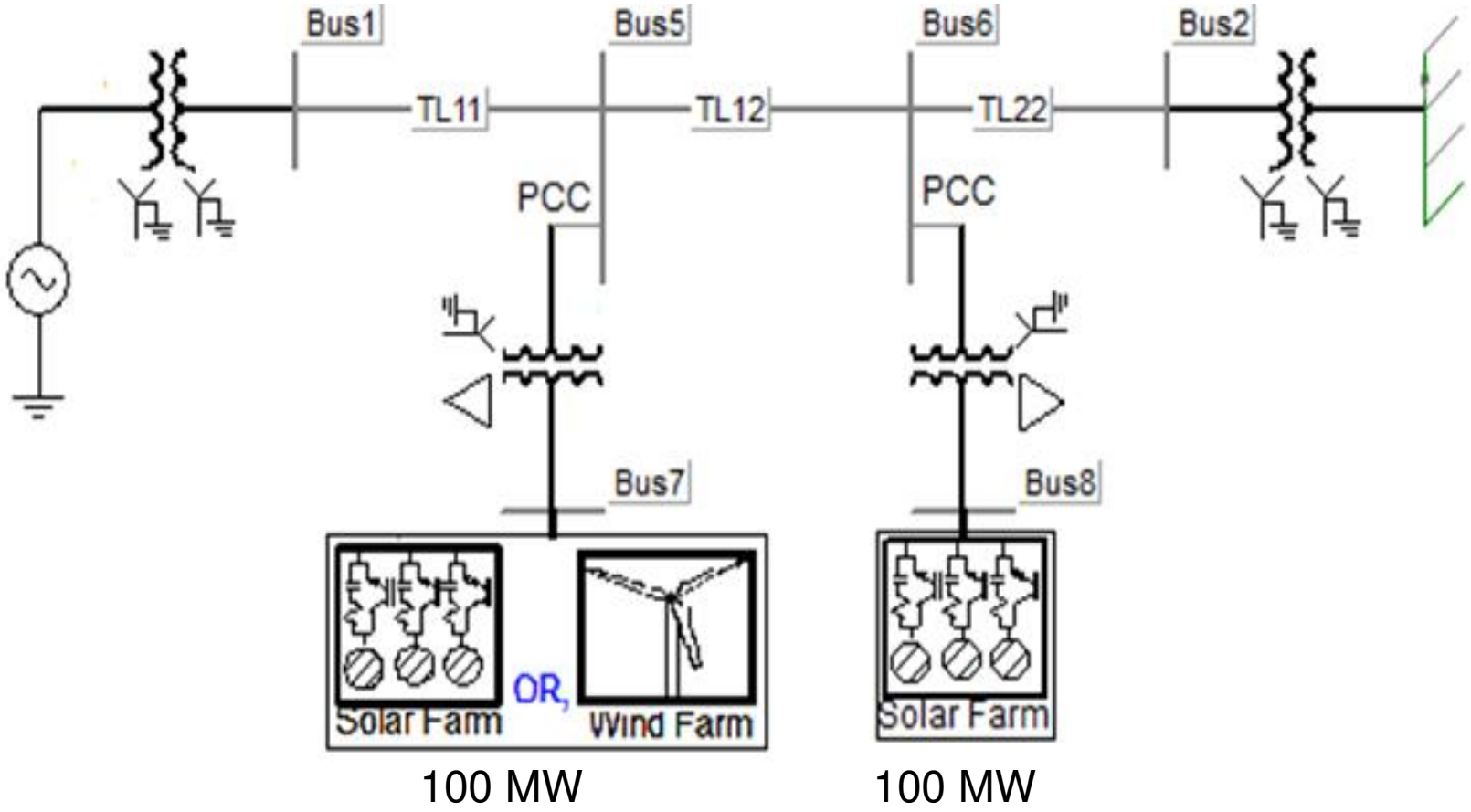
Voltage and damping control



Day time

Damping control; P_{PV}=91MW

Study System - 2



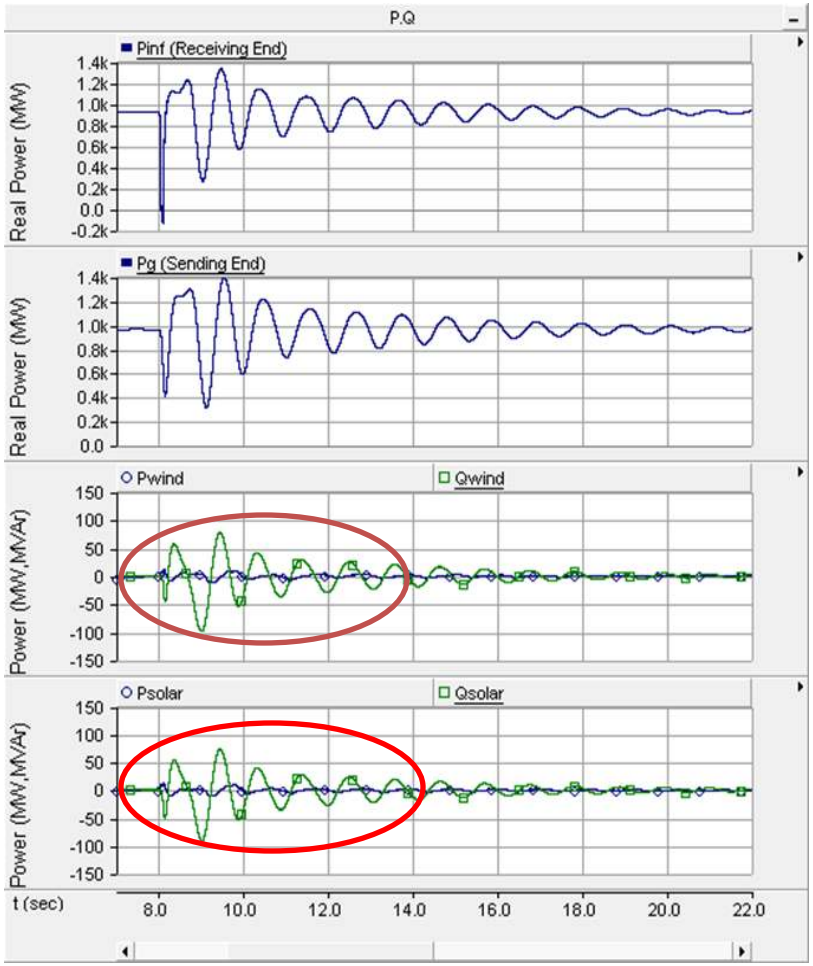
SMIB system with 2 x 100 MW solar farms on a 200km line

SMIB System with Two DGs as STATCOM

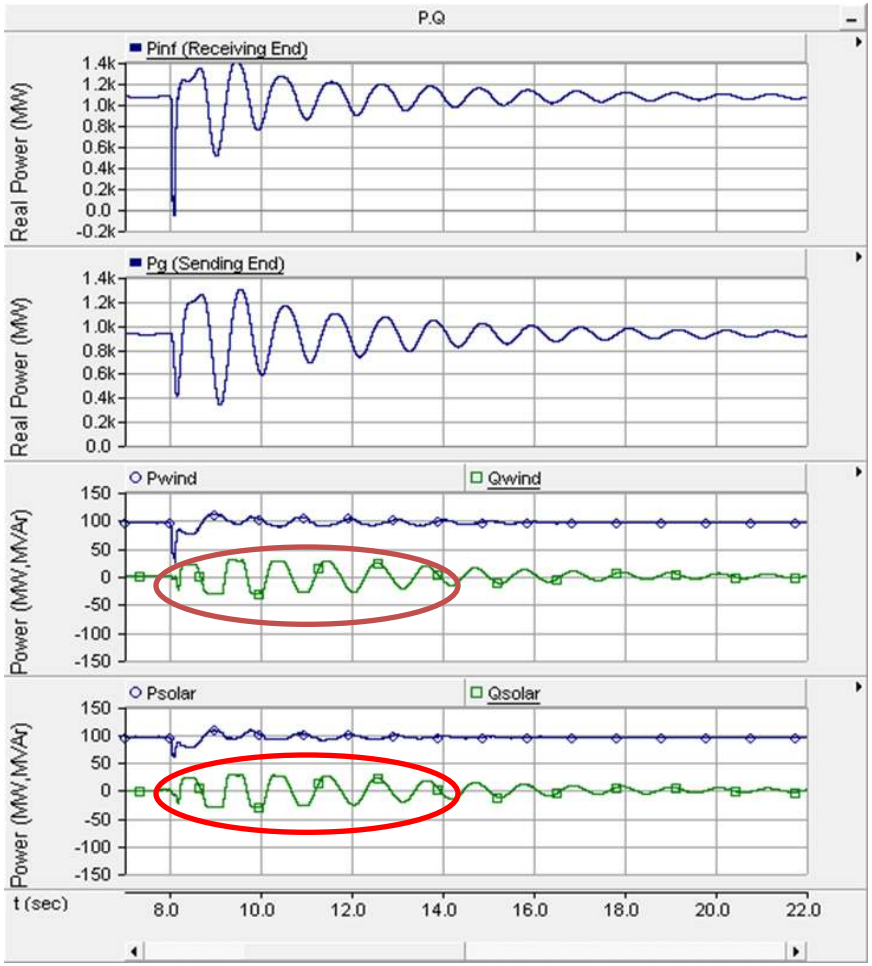
Power transfer improvement with damping control

DG Real Power Outputs (MW)	Maximum Power Transfer Limits (MW)		Net Increase in Power Transfer Limit (MW)
	Without Damping Controller	With PV-STATCOM Damping Controller	
Nighttime			
P_{solar}=0; P_{wind}=0	731	960	229
P_{solar}=0; P_{wind}=20	729	948	219
P_{solar}=0; P_{wind}=95	716	936	220
Daytime			
P_{solar}=20; P_{wind}=20	726	923	197
P_{solar}=95; P_{wind}=95	700	930	230
P_{solar}=20; P_{wind}=0	730	944	214
P_{solar}=95; P_{wind}=0	719	938	219

SMIB System with Two DGs as STATCOM



Nighttime (damping control)



Daytime (damping control)

Conclusion

- Novel Control proposed for PV Solar Farm inverter as STATCOM , termed PV-STATCOM.
- PV- STATCOM utilizes voltage and damping control with "unused" capacity of PV inverter.
- Provides significant enhancement of transient stability and power transfer capacity, very cost-effectively.
- Similar STATCOM controls can be implemented on inverter based wind turbine generators.

Conclusion

- PV-STATCOM technology has the potential to bring
  - New revenues to solar farms during night and day
  - Better network performance for utilities

- Appropriate agreements will be required between regulators, utilities, solar farm developers, and inverter manufacturers

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Thank You
Questions ?