



Storage with Utility Scale PV Systems

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World View

CPUC voted to evaluate energy storage needs

- Mandate energy storage for utilities

a 20-megawatt Beacon Power flywheel energy storage farm filed for Chapter 11 bankruptcy

- Acquired by Houston-based Rockland Capital

Renewables provided for 25% German electricity demands in first half of 2012

- Target of 35% & 50% in 2020 & 2030 respectively

PV and IL

- 10MW PV farm in Chicago by Exelon
- Over \$30 million DOE funding in IL for PV: over \$24 million is on PV and storage integration
- \$4.5 million ARRA grant to ComEd for research on PV and energy storage

Energy Storage Landscape

Application

- Standalone (off grid or on grid)
- Hybrid

Type

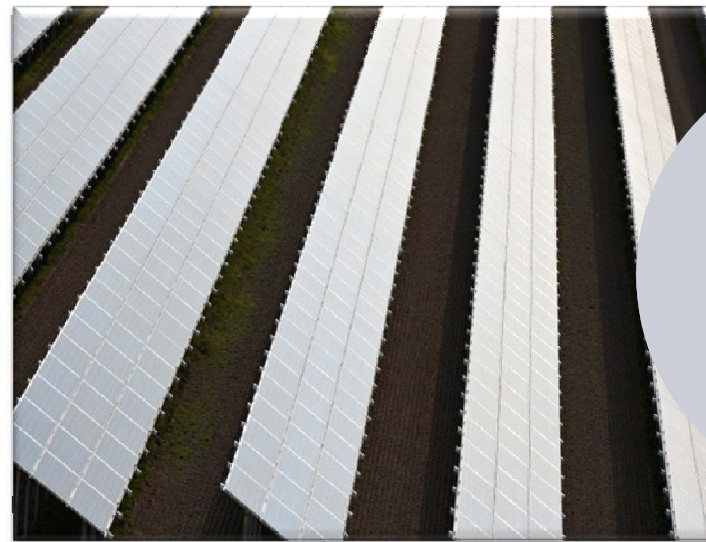
- Batteries (Lead, Nickel, Lithium, Flow, etc.)
- Pumped storage
- Molten salt
- Flywheel

Market

- Forecasted to grow from \$0.5B in 2011 to \$113B in 2017
- Average growth forecast of 170% from 2012 to 2017

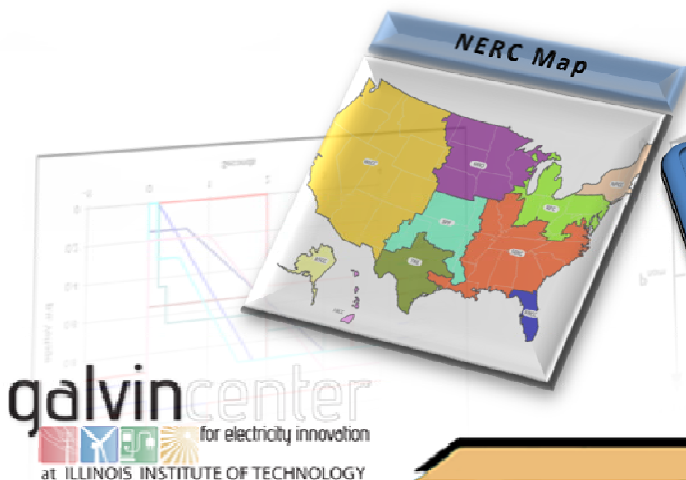
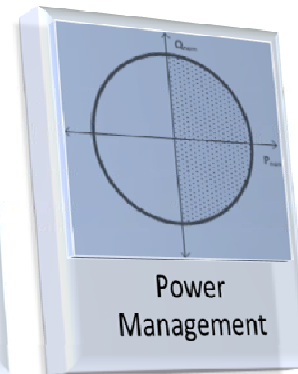
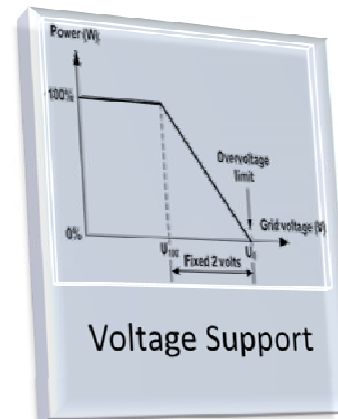
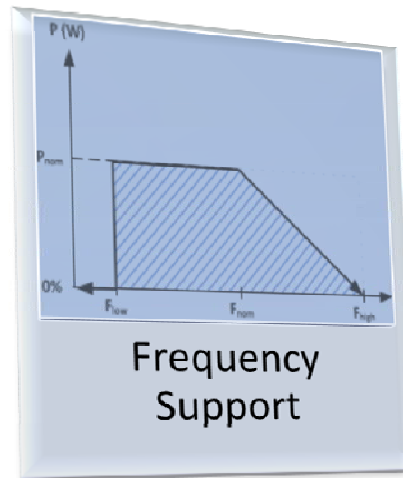
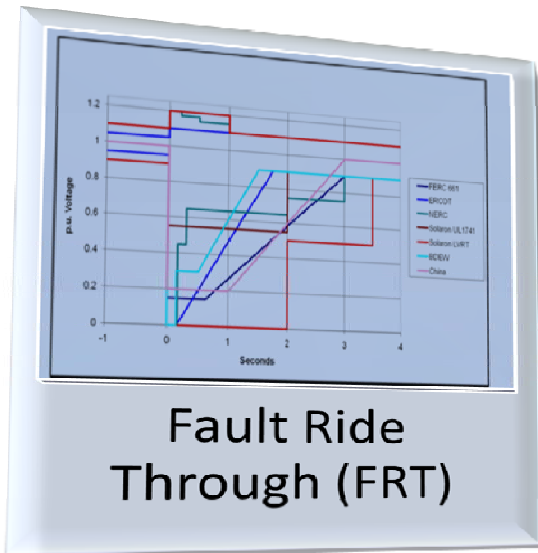
Key Drivers for Storage Application

- 'Island' area
- Grid stability & power quality
- Peak shaving & load leveling
- Renewable integration
- Price arbitrage



PV
systems:
part of the
solution

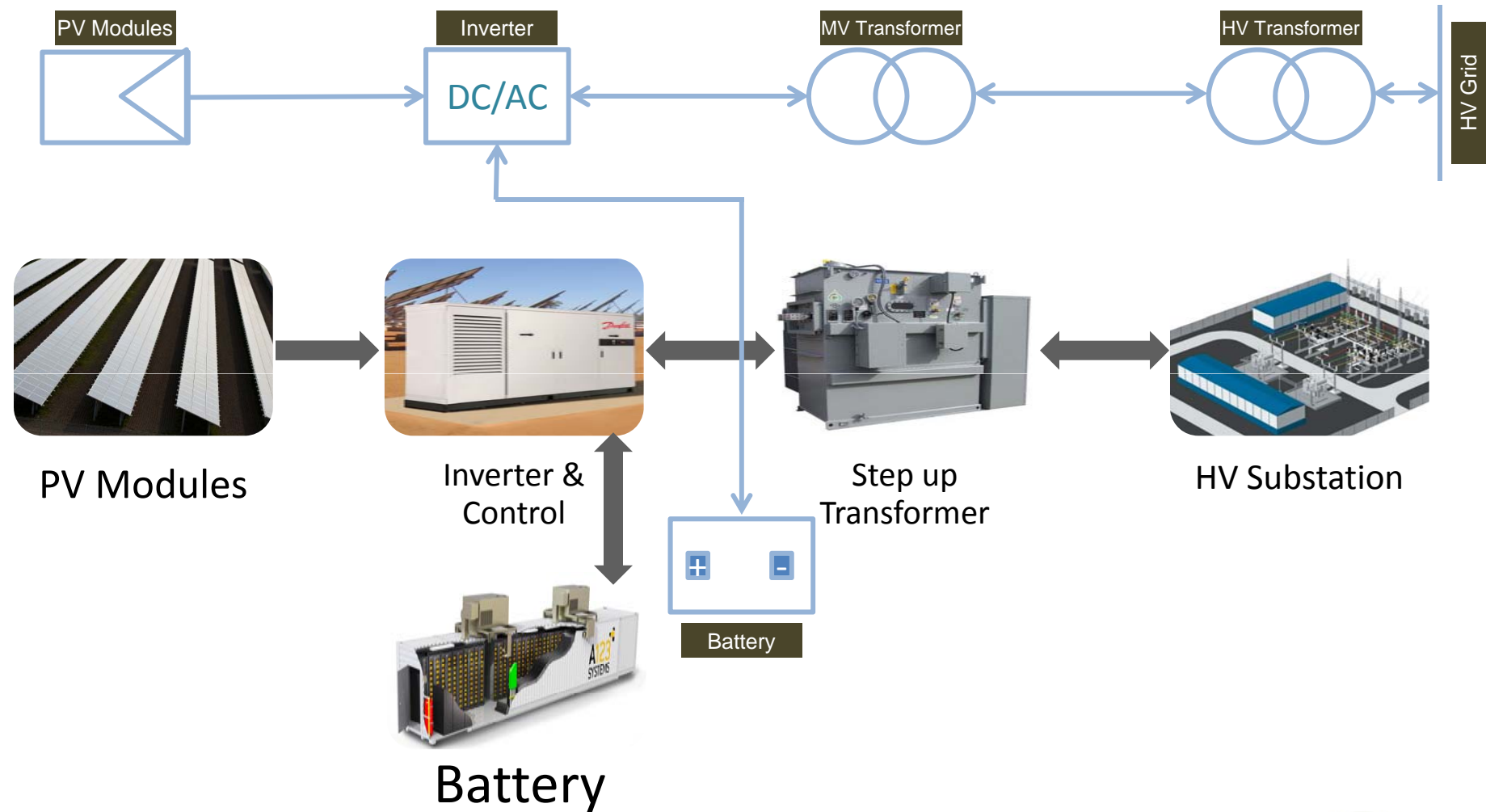
Grid Interface Requirements for PV



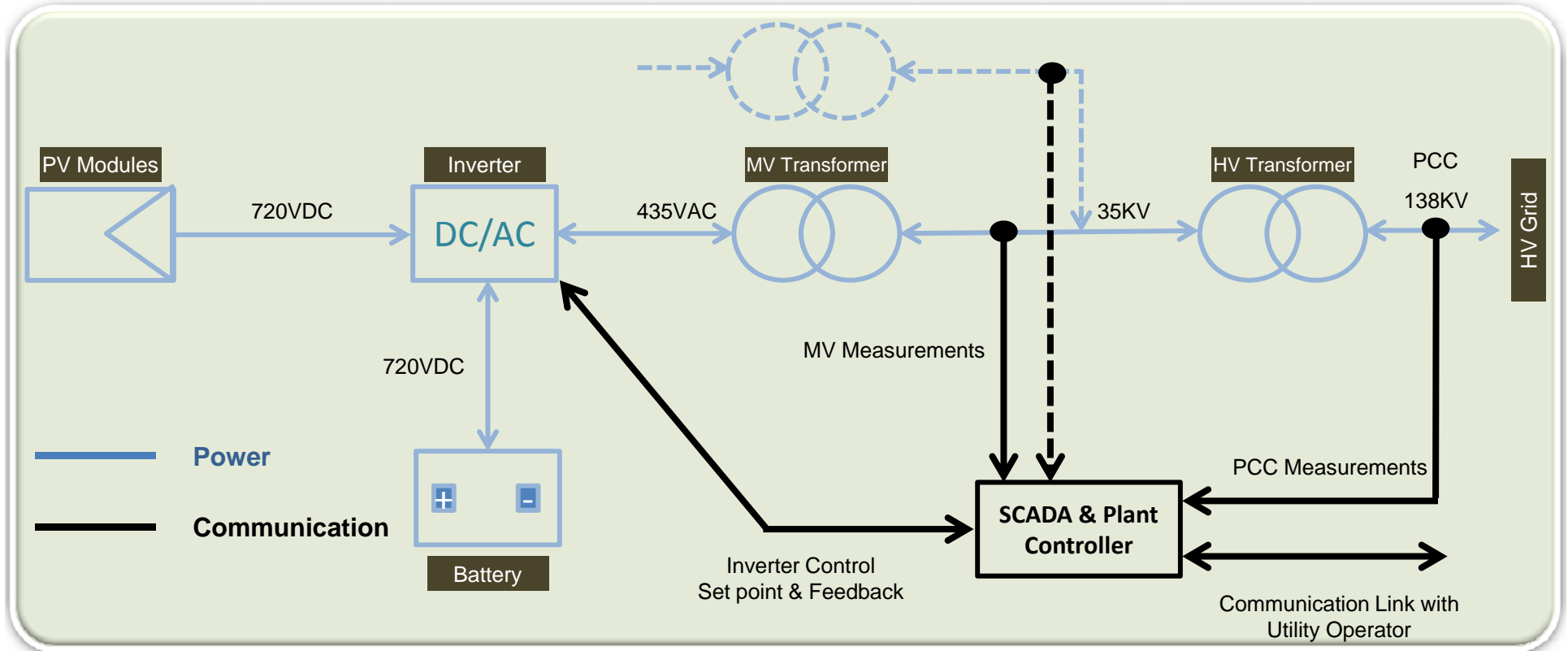
**Diversified grid codes
More sophisticated response is required**

Sources: [EPA](#)

PV and Storage Integration



Grid Integration

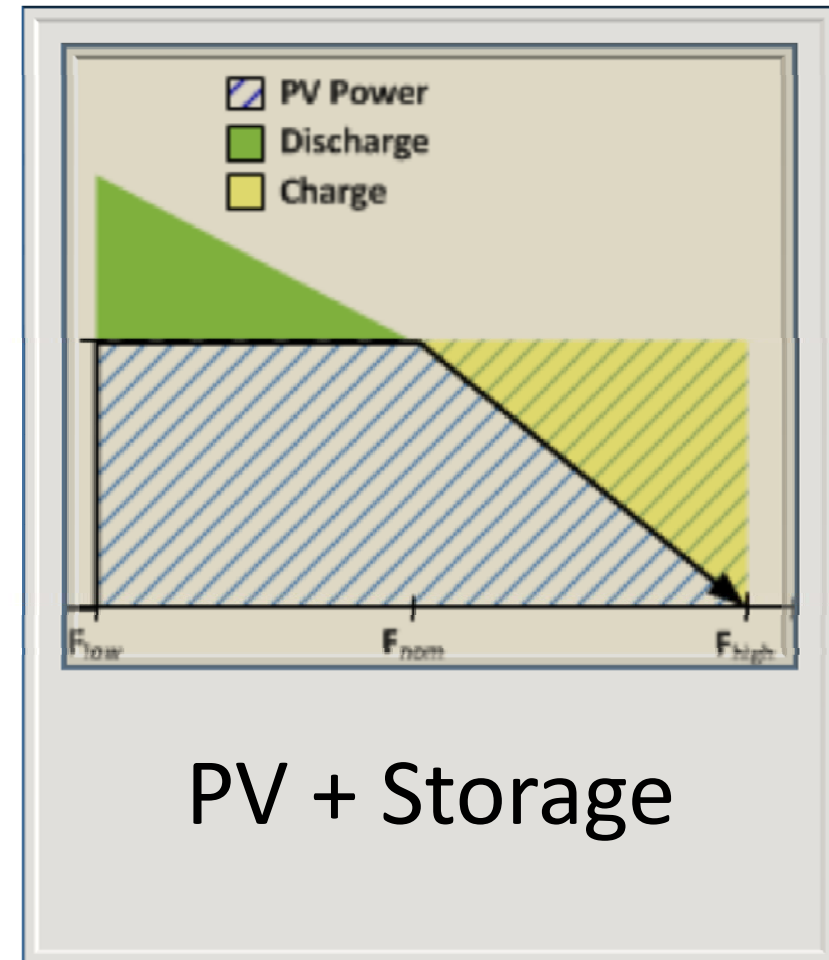
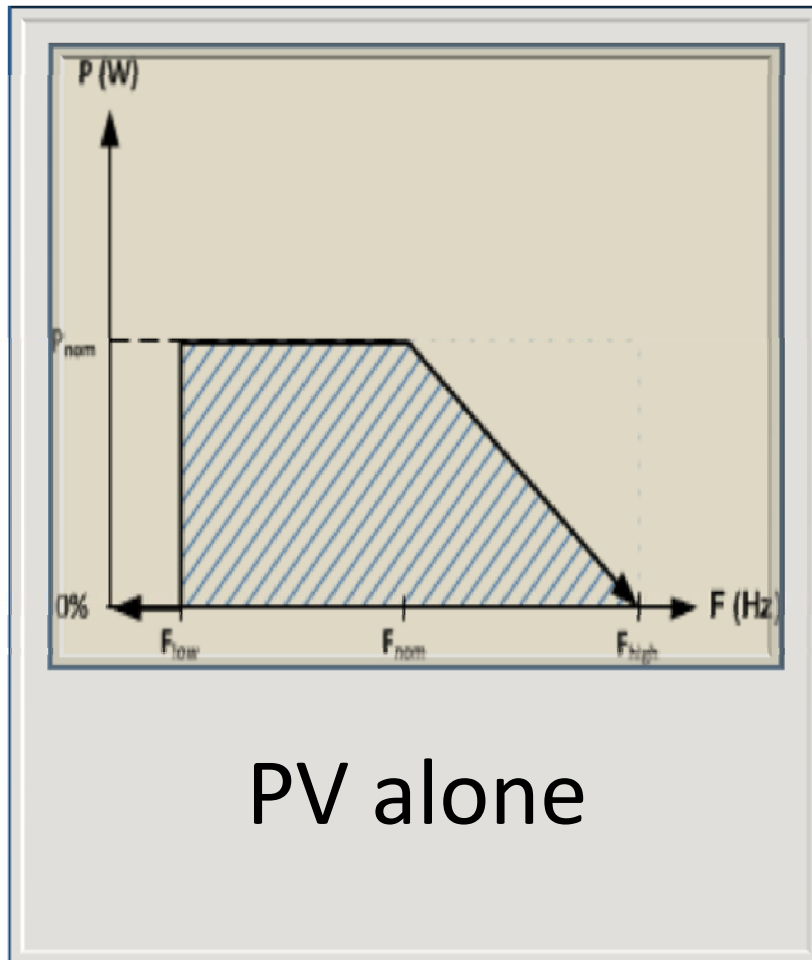


Utility communication: Active/reactive power, power factor, power curtailment, Prioritization, voltage/frequency support...

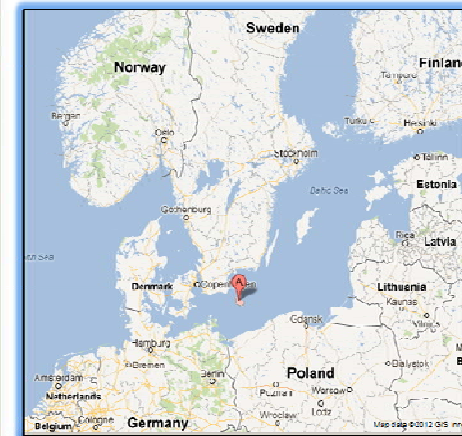
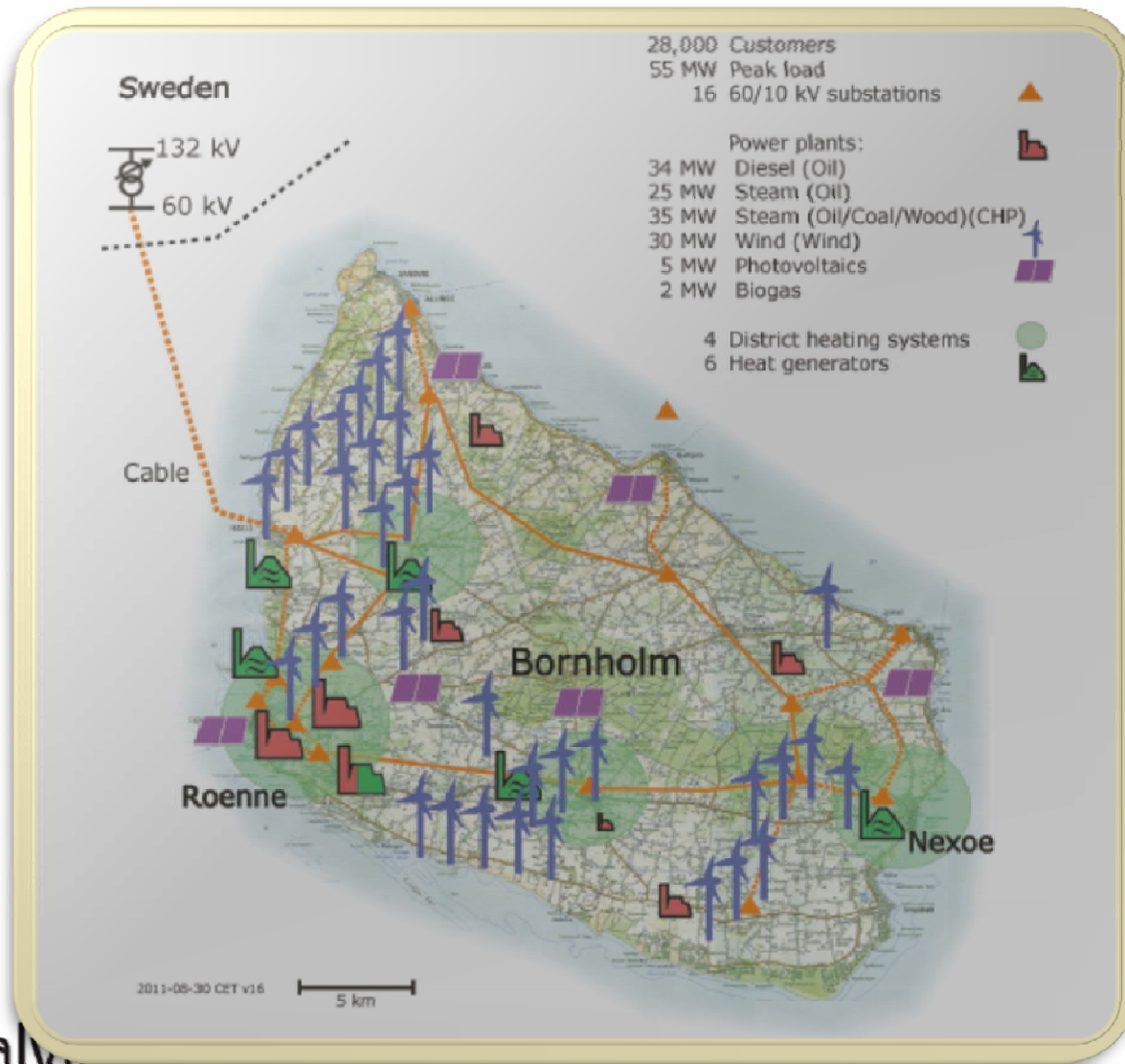


Closed loop control

Frequency Support



Smart Grid for Bornholm



Summary

- Great synergies between PV and storage
- PV adds an additional degree of freedom in storage equation: optimization for increased ROI
- PV + storage: the whole is greater than the sum of its part!