

ENERGY

Cost-effectiveness Studies of the BESSs Participating in Frequency Regulation

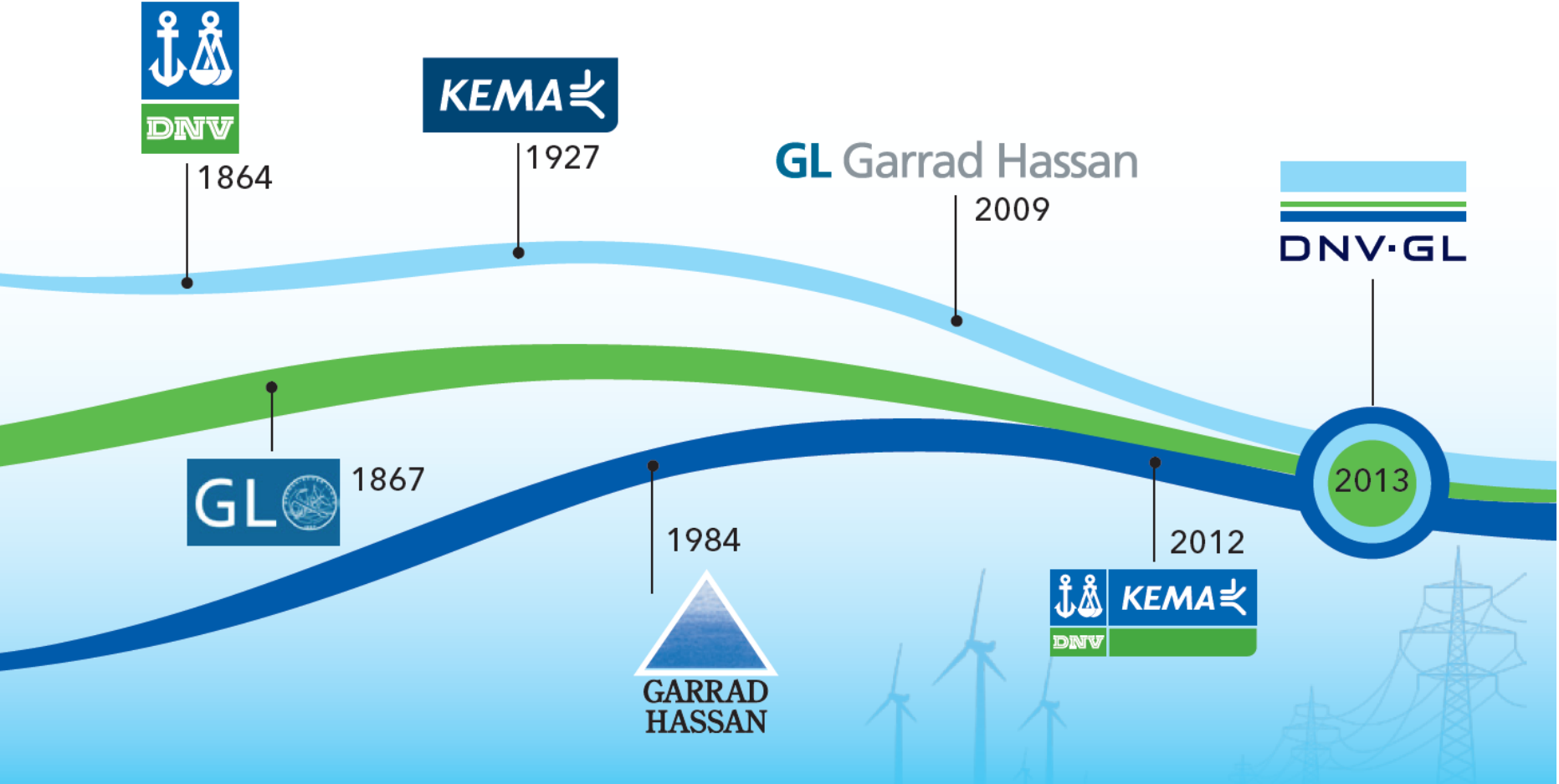
NRF2014EWT-EIRP002-005

DNV GL & NTU

Chen Shuaixun

05 November 2015

DNV GL – 150 years of legacy

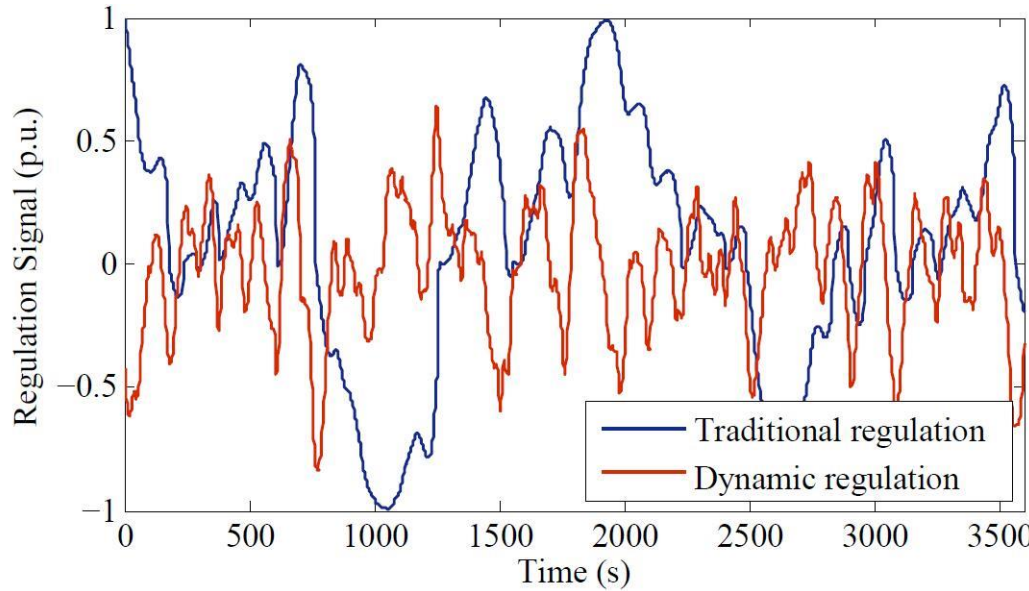
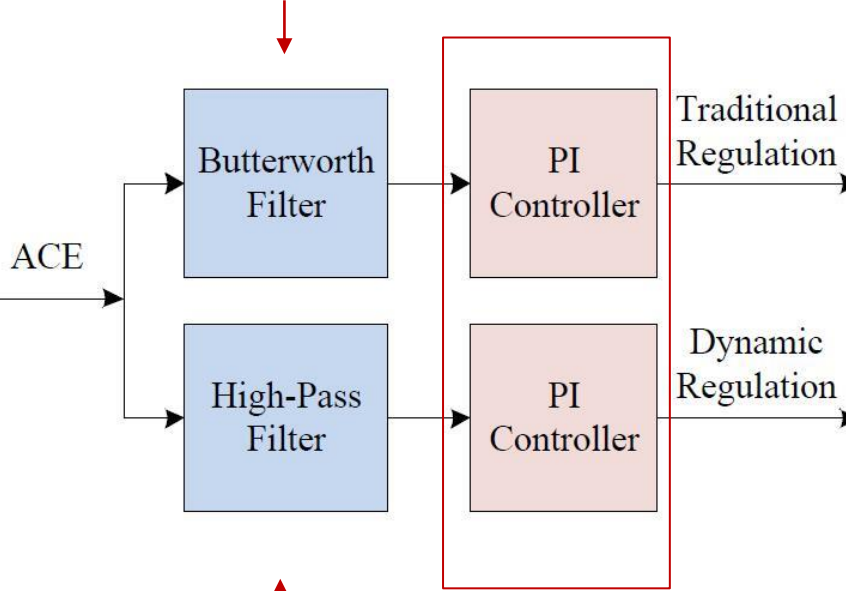


Assisting companies in solving the energy trilemma



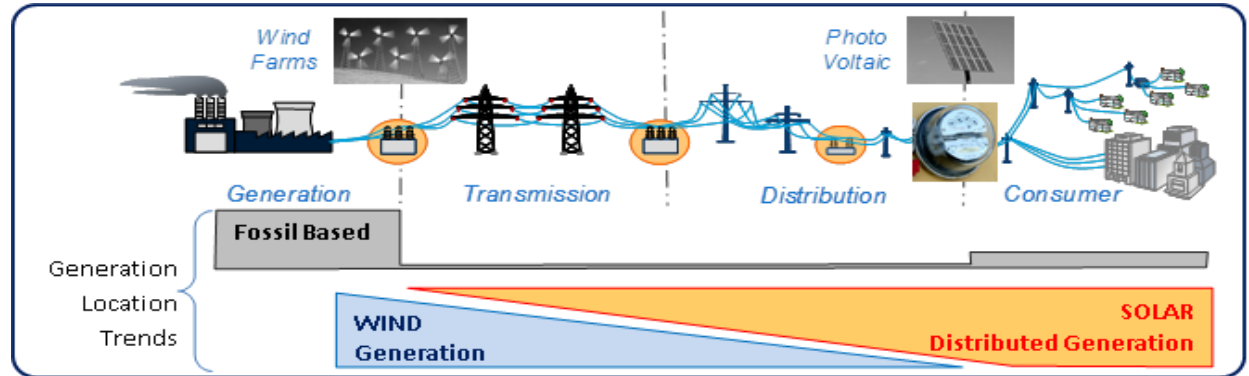
An overview of Load Frequency Control

To accommodate the slower ramp rates



Overview of Electric Grid and Storage Applications

- Electric grid is a mix of bulk and distributed as well as fossil and renewable generation. The mix ratio changes with location & time.

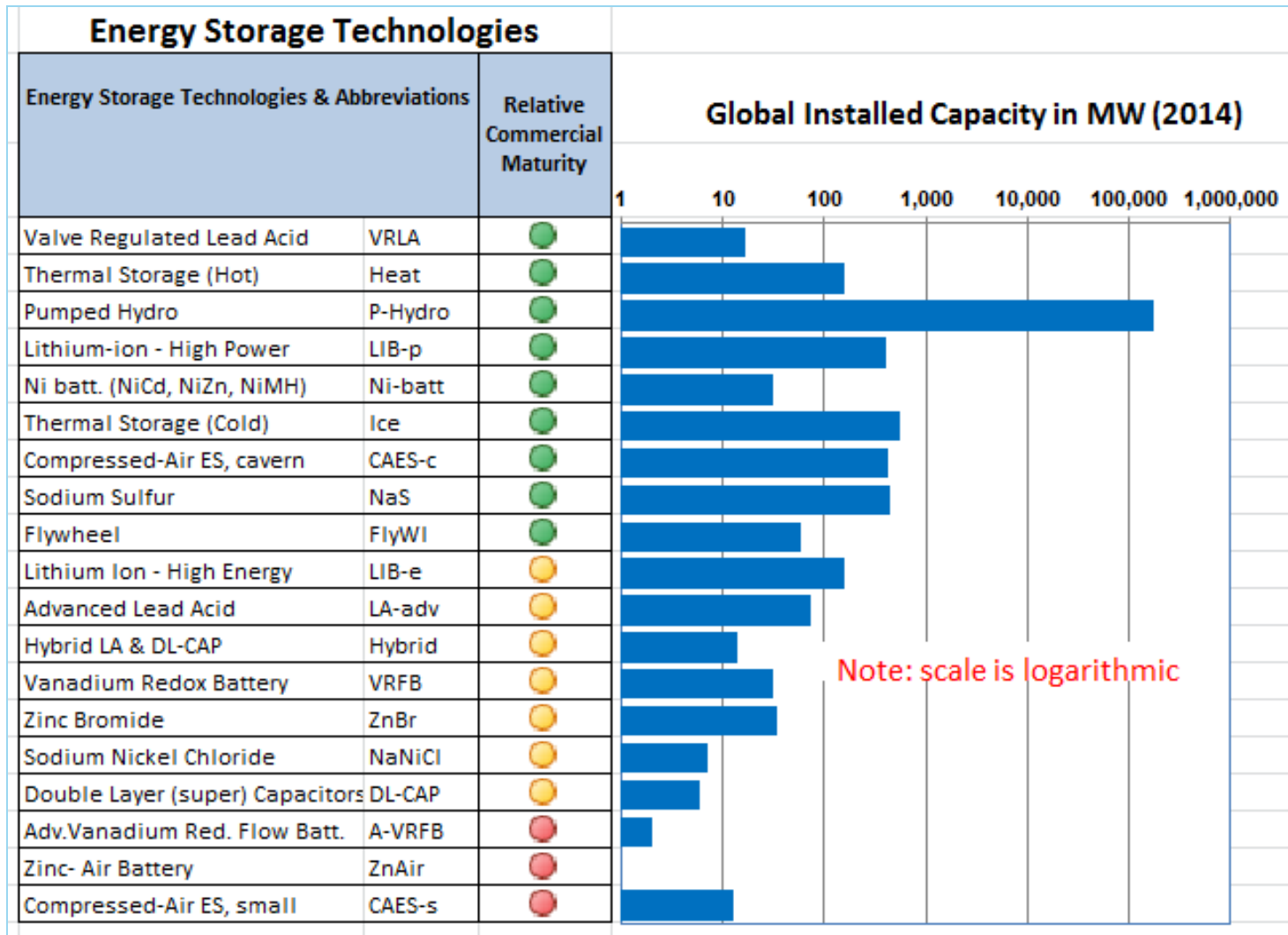


- There are many storage applications that offer different values at different parts of the grid

Value Groups	Energy Storage Value Groups at different Grid Locations		
Energy	Renewable Energy Value Enhancement		
	Buy Low – Sell High	Reduce Energy Charge	
	T&D Upgrade Deferral		
Power (capacity)	Provide G,T&D peak capacity		Reduce Demand Charge
Power (Variability)	Frequency Regulation		Power Quality
	Renewable Smoothing		
	Voltage Support		
Service Reliability	Black Start	Supply Reserve Capacity	UPS & Backup
	Congestion Relief		

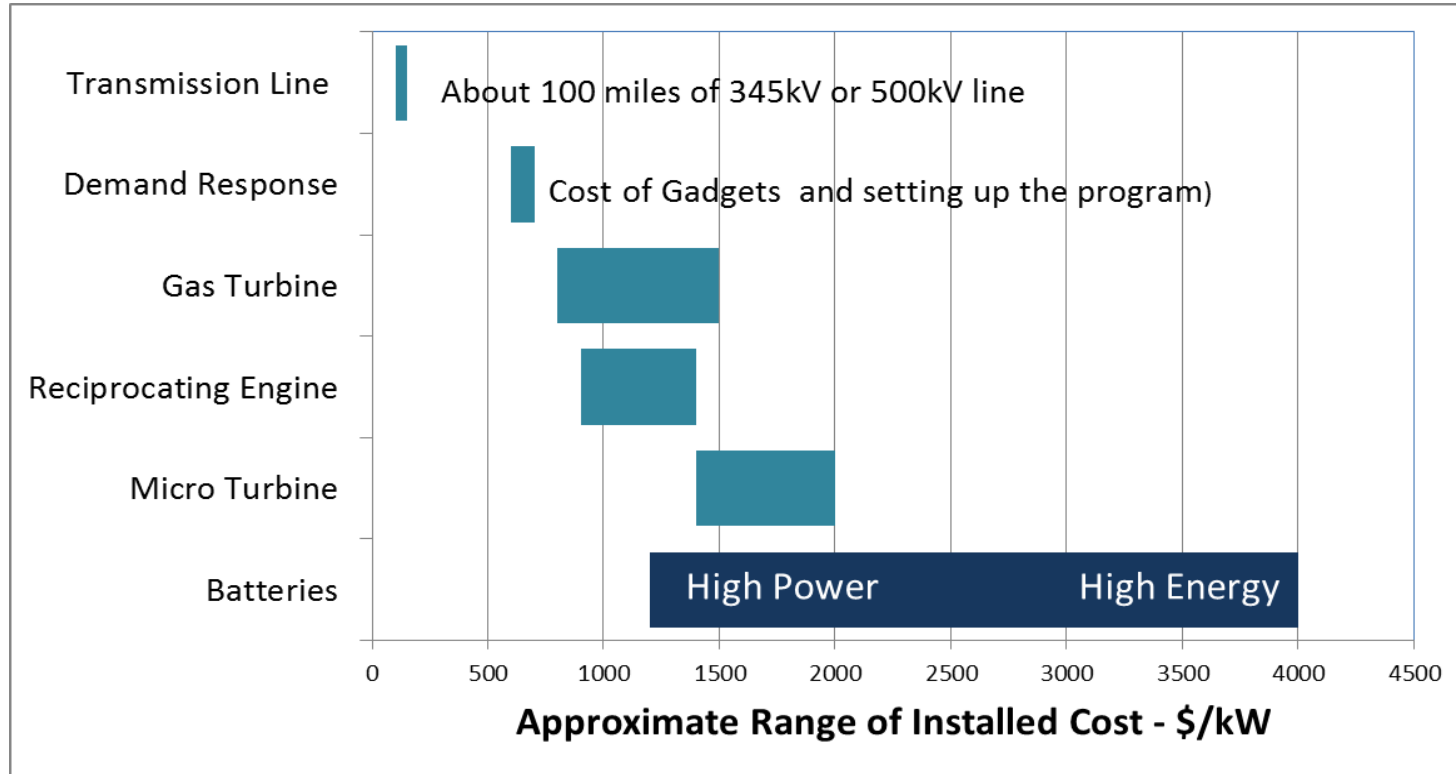
DNV-GL

Relative Maturity and installed Capacity of Storage Technologies



Simplified Comparison of Storage with Alternatives

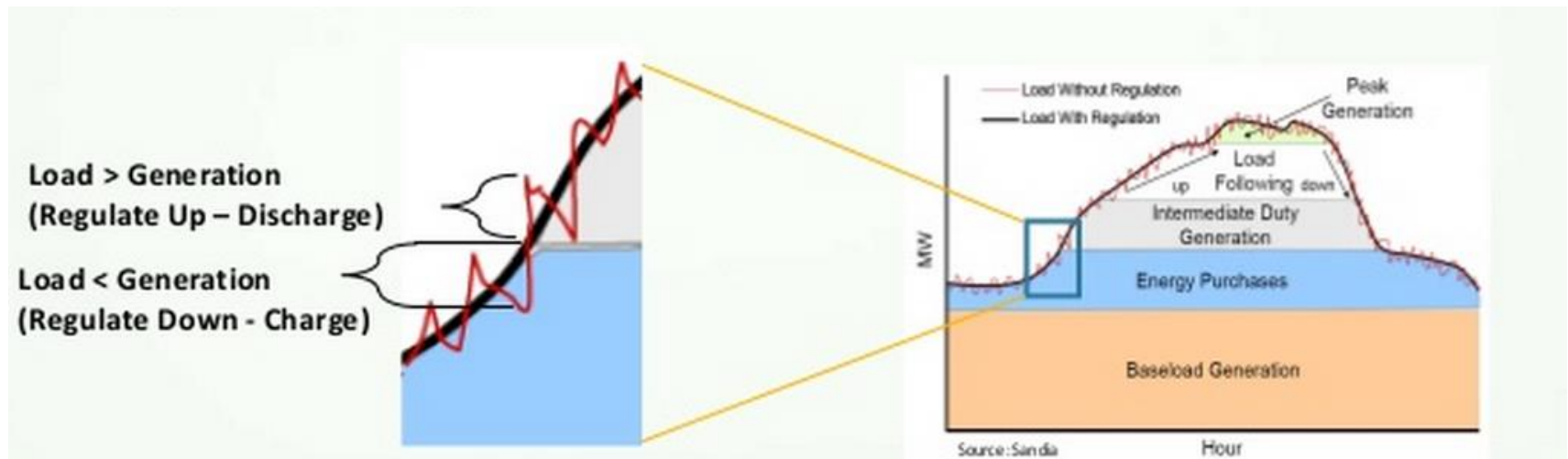
For a single application, storage is often more expensive than its alternatives, **but so is a smart phone compared to a desk phone**



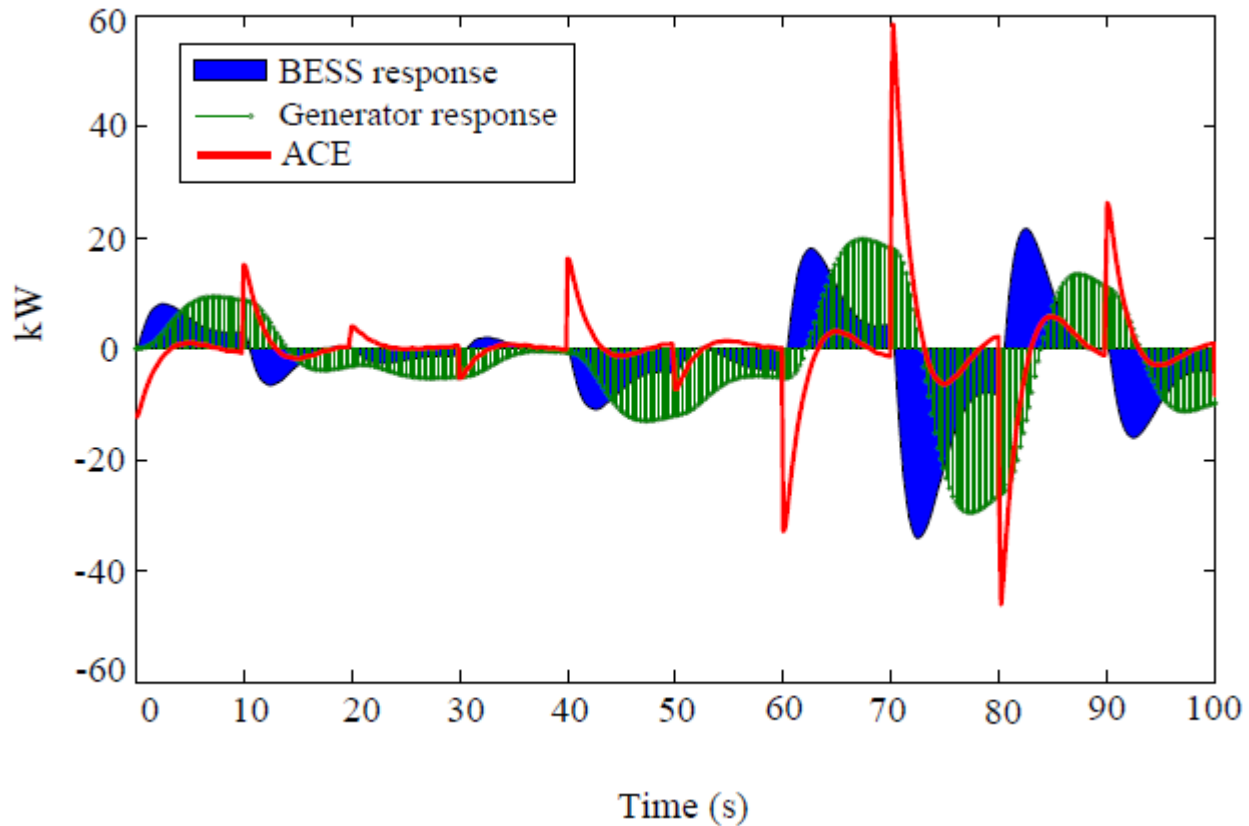
Difference: Smartphone already offers tens of applications but storage is yet to be offered with bundled applications and controls to realize the higher value

Performance Based Frequency Regulation

- Frequency Regulation

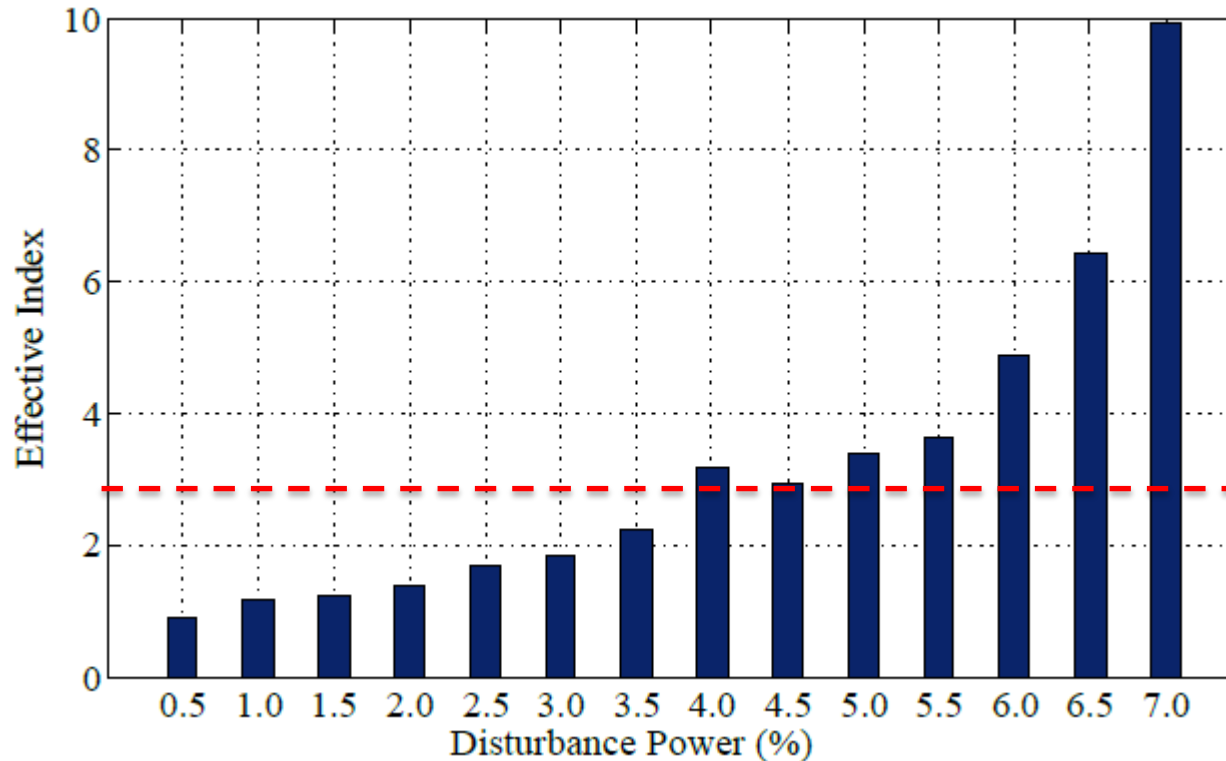


Performance Based Frequency Regulation



BESS response is much faster than traditional generator

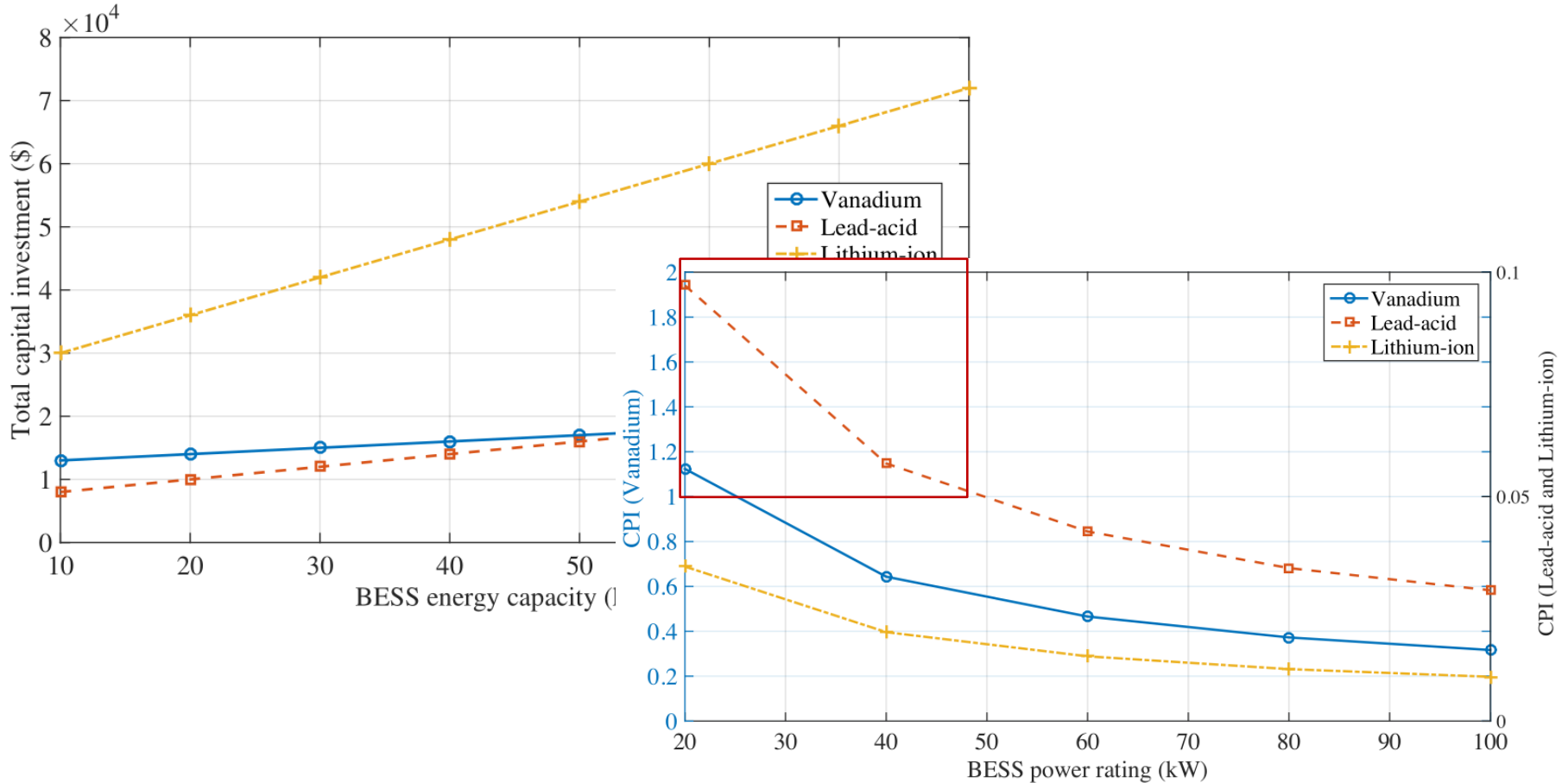
Performance Based Frequency Regulation



FERC order 755

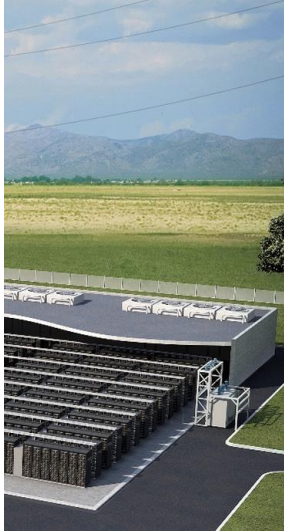
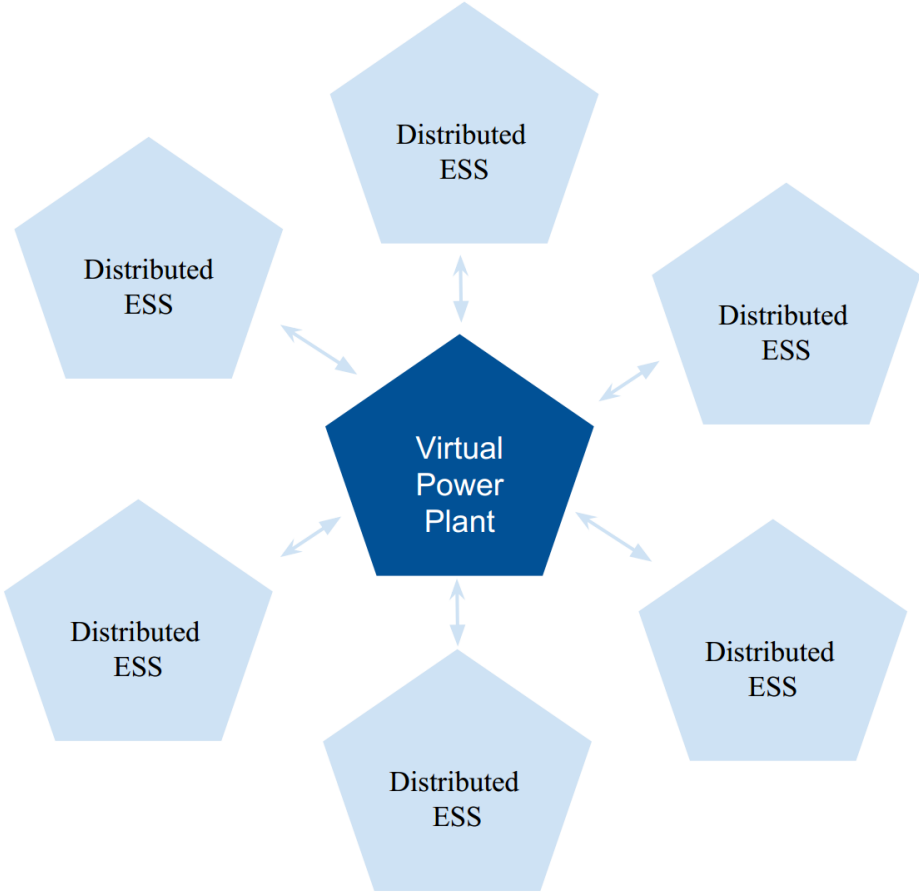
BESS is three time more effective compared with traditional generator

BESS Cost-Performance Index (CPI)

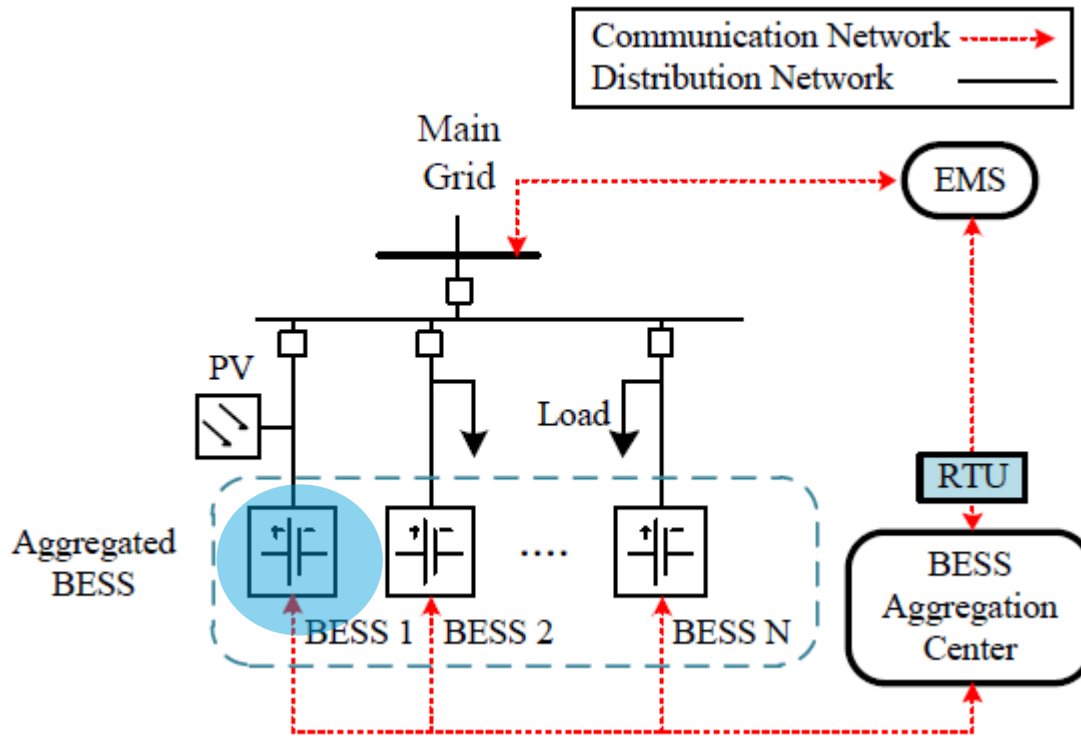


CPI > 1 means profitable

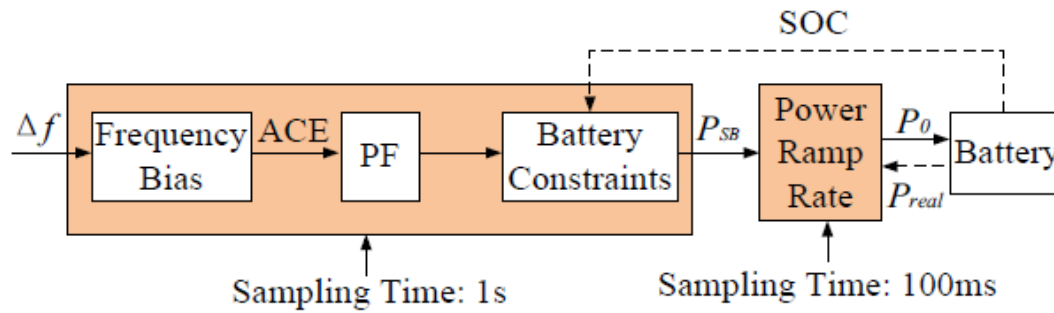
How to Implement Energy Storage System



Virtual Power Plant Concept



Virtual Power Plant Concept



Conclusions

- BESS is more effective compared with traditional generator in term of frequency regulation performance
- However, BESS is hard to be profitable only for frequency regulation function
- Virtual Power Plant Concept may work combining energy shifting, frequency regulation and demand response

Thanks

Shuaixun.chen@dnvgl.com

www.dnvgl.com

SAFER, SMARTER, GREENER